

**GTE GLASS PRODUCTS CATALOG**



# Introduction

In 1970, GTE Products Corporation, known then as GTE Sylvania, built and started a glass manufacturing plant in Greenland, New Hampshire. This plant was designed to manufacture tubular bulbs for fluorescent lamps.

In 1973, Glass Operations expanded into the manufacture of lead tubing in a new glass plant in Versailles, Kentucky. In 1982 and 1983, GTE bought two glass manufacturing plants from Corning Glass Works, located in Wellsboro, Pennsylvania and Central Falls, Rhode Island. This expanded their business to glass bulbs, both in hard glass and soft glass.

While the main impetus for GTE establishing a glass operation was to supply high quality glassware to its lamp plants, this has necessitated building an organization and equipment capable of producing precision tolerance, high quality specialty glassware at high speed. This capability has allowed us to enter businesses other

than lighting glassware. Some of these new applications are:

- Glassware for thermal control devices.
- Glassware for electrical fuses.
- Glassware for cathode rays, television, power and radio tubes.
- Glass pellets for the fiberglass filter industry.
- Vacuum bottle glassware.
- Christmas tree ornaments.
- Lighting fixture parts such as globes, shades and chimneys.
- Glass giftware such as vases, Chandelle™ lamps, and cheese domes.

Our glass melting expertise includes melting both hard and soft glasses. The properties of these glasses are formulated to suit technical applications, such as expansions to match the glass sealing metals, special electrical properties or special optical transmittances. The lamp working characteristics of these glasses are very closely maintained through the control of glass chemistry and viscosity curve.

Our forming capability runs from drawing

tubing .064" O.D. to 2.500" O.D., blowing bulbs from 3/4" in diameter to 10" in diameter, or from 1 1/2" long to 16" long. These items are manufactured to some of the tightest tolerances in the industry. We also have the ability to manufacture blown pieces with textured surfaces.

Our finishing capability includes chemically etching an inside frosted surface to tightly prescribed light scattering limits, ceramic painting outside surfaces and coating surfaces with silver, aluminum and lustres.

We invite inquiries for new shapes and applications. Questions should be addressed to:

Sales Manager  
GTE Products Corporation  
Route 101  
Greenland, New Hampshire 03840

## Quality Statement and Return Procedures

### Intent

GTE Glass Products' objective is to supply quality ware.

We manufacture our ware using statistical process control of key dimensional criteria and statistical frequency audits of key visual defects. Our experience using these controls is that 99% of our ware can be used without incoming inspections and without excessive shrinkages. We recognize that occasionally defective or unusable product will slip through our control procedures. This procedure describes how these instances are handled:

### Defective Ware

Should a lot or shipment of ware contain defective material in significant quantity, GTE will replace it or arrange a mutually satisfactory disposition.

*Defective material* is defined as ware which has measured dimensions outside of published tolerances and visual defects outside of published quality criteria. These tolerances and quality criteria are defined

in individual specifications and in the following Bulb Criteria publication.

- BC1 - Soft Glass Blown Bulbs
- BC2 - Hard Glass Blown Bulbs
- BC3 - Blown Shapes (Ornaments and Molds)
- BC7 - Fluorescent Bulbs
- BC8 - Soft Glass Tubing
- BC9 - Cut Soft Glass Tubing
- BC10 - Hard Glass Tubing

These and individual specifications are available from the Sales Department, Greenland, New Hampshire.

If a customer finds that tighter tolerances or limits are required for their product or process they should notify the Sales Department. Mutually acceptable tolerances can then be agreed upon and individual specifications published.

*Significant quantity* is defined as follows:

No "Overall Accumulative AQL" is required because our statistical process control should yield close to zero defect levels for any one type.

When a customer finds a lot of ware which does not meet the above criteria, he may notify either the Sales Department, Greenland, New Hampshire or the Supervisor of Quality Control of the producing plant (whichever would be the most expedient.)

### Ware Causing Excessive Process Shrinkage

Our goal is to keep our customer costs competitive through low shrinkages. We acknowledge that our ware *may* cause excessive customer's shrinkage but it is not rejectable by the above "Defective Ware" criteria. If a customer feels this situation exists, he should contact the Sales Department, Greenland, New Hampshire and be prepared to discuss:

1. The nature of shrinkage
2. Description of the ware
3. Quantity of ware involved
4. Production date of the ware

He may be asked to send samples or arrangements may be made for a visit to his plant to assist in determining the cause of the shrinkage. Ware of different production date may be shipped to him so he can maintain his production lines. This should not be construed as an admission that the ware is defective.

*Other defects:* all other defects are either "set up" controlled or random in occurrence. Our goal is to maintain that frequency below an acceptable level.

*continued*

### Ware with Excessive Breakage

GTE Glass Products does not guarantee any level of breakage or generally does not give credit for broken ware. However, we want customers to receive ware with a minimum of breakage. We will actively work with customers to improve packing, develop routing and carriers to minimize breakage. If a customer receives ware with excessive breakage, we strongly urge that he immediately place a claim on the carrier, and notify the Sales Department in Greenland, New Hampshire so we can work together to resolve the problem.

### Ware with Weathering or Tarnished Silver

Lime glass blown bulbs over two months old are inspected for excessive weathering prior to shipment. Silvered bulbs are metalized within two weeks of the release date. Customers should inspect lime glass items and all silvered ware within one week of receipt. GTE Glass will not honor requests for credit for weathered or tarnished ware if the inspection took place more than one week after receipt at the customer's plant.

### Administrative Problems

If a customer receives ware which is mislabeled, or shipments which are short shipped, or wrong count on invoice, or overshipped requirements (by 10%) etc., the customer should notify the Sales Department in Greenland, New Hampshire.

### Disposition of Ware and Credit

When notifying GTE Glass Products, be prepared to give the following information:

1. Description of ware
2. The quantity in question

3. The manufacturing date or shipment date and invoice number
4. Description of the problem. For *defective ware* – the defects involved, the sample size, and % defective. For *breakage* – % broken and condition of the packing material or shipment. For *excessive shrinkage* – the nature of the shrinkage, frequency, and process description.

Depending on the above information, the customer may be asked to forward samples for verification of the defect and/or analysis of the cause of the problem. If GTE determines the ware is defective, the customer and GTE representative may agree to one of the following for disposing of defective ware:

1. *Return and receive credit:* the customer will be authorized to return the ware to the plant of manufacture. Upon receipt at the plant, the procedure for issuing credit for the returned ware will be initiated.
2. *Replacement of defective ware:* the customer will be authorized either to return the ware or scrap it and the producing plant will ship fresh ware.
3. *Scraping ware and credit:* the GTE representatives will authorize the customer to scrap the ware and immediately initiate the credit procedure.
4. *Customer uses the ware and GTE Glass reimburses him for sorting and shrinkage costs:* only a representative of GTE Glass Products Sales Department can authorize GTE's assuming liability for a customer's sorting costs and shrinkages. This alternative will only be used where it is beneficial to both parties.

### Unauthorized Returns

GTE representatives will make every effort to resolve the disposition of questionable ware as quickly as possible.

If a customer feels that service is not expeditious, we encourage calling the Marketing Manager at (603) 436-8900 and matters will be resolved. However, **GTE Glass Products assumes no liability for ware returned without prior authorization and no liability for additional costs incurred for customers using questionable ware without a prior agreement with a representative of the Sales Department.** This policy includes ware returned under a customer's unilateral policy of automatically returning rejected ware after a prescribed time limit of notification.

### Limitation of Liability

GTE's liability under this Statement is limited to replacement or credit for ware which GTE determines is defective under the meaning of this Statement. Under no circumstances does GTE assume liability for any consequential damages such as labor for replacement, shut down of assembly lines, cost of procurement elsewhere, etc.

## Glass Applications Engineering Services

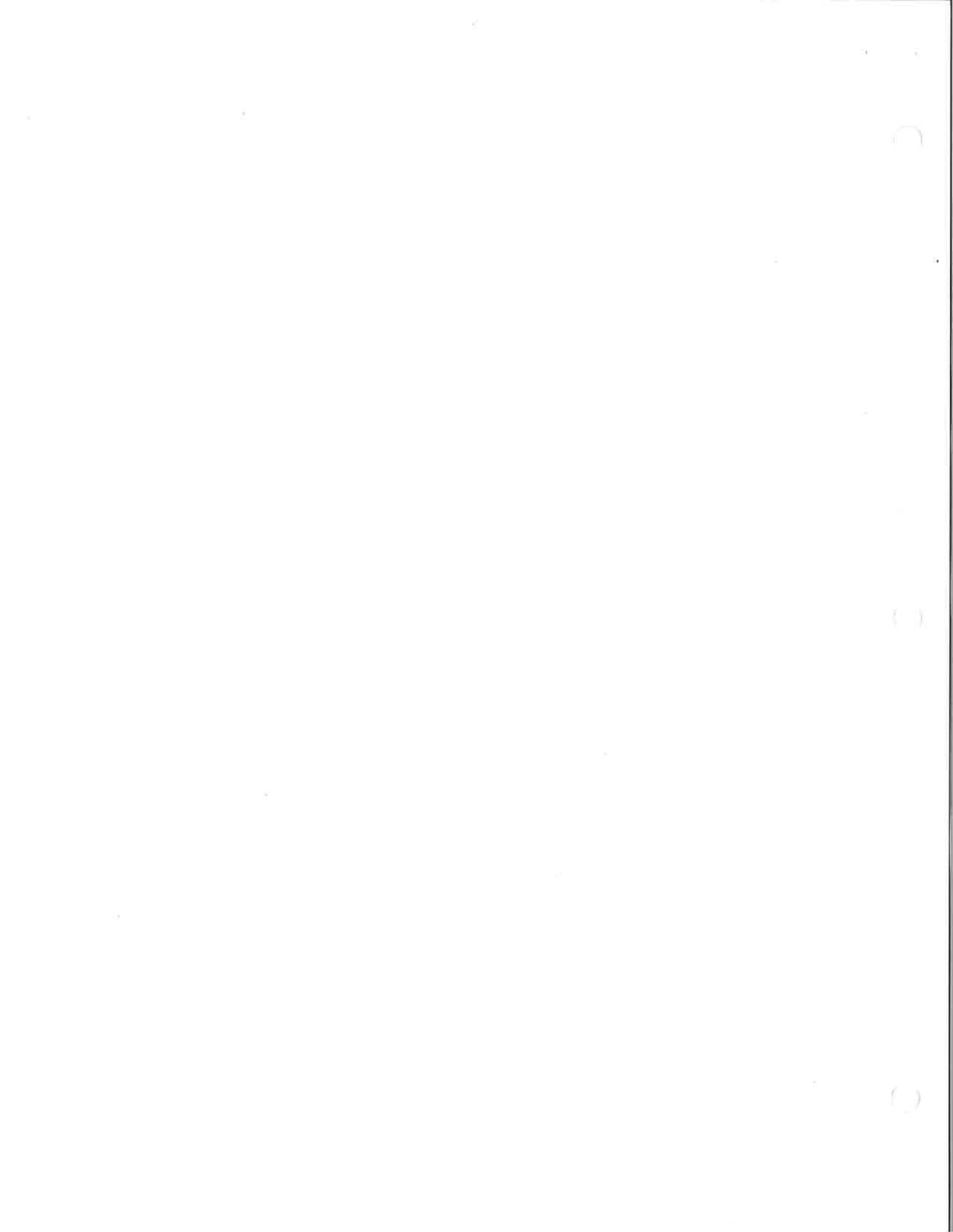
Customers sometimes find that the quality as manufactured does not meet their requirements. Sometimes customers find that a lot of glassware does not process similar to other lots, and yet all lots seem to be within all specifications. For these occasions, we have an Applications Engineering Service. These are engineers who have expertise in stress analysis, break source analysis, and who understand lamp-working techniques and interaction between glass, lead wires, and the fires.

They are available to work on customers' process with customers' engineers and production foremen in defining the causes of the problem and test possible solutions. The goal of this type of service is to find a specification for the glassware and a control of a process variable which will result in the lowest shrinkage for the customer.

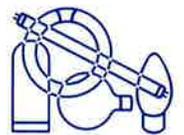
This service is also available to give

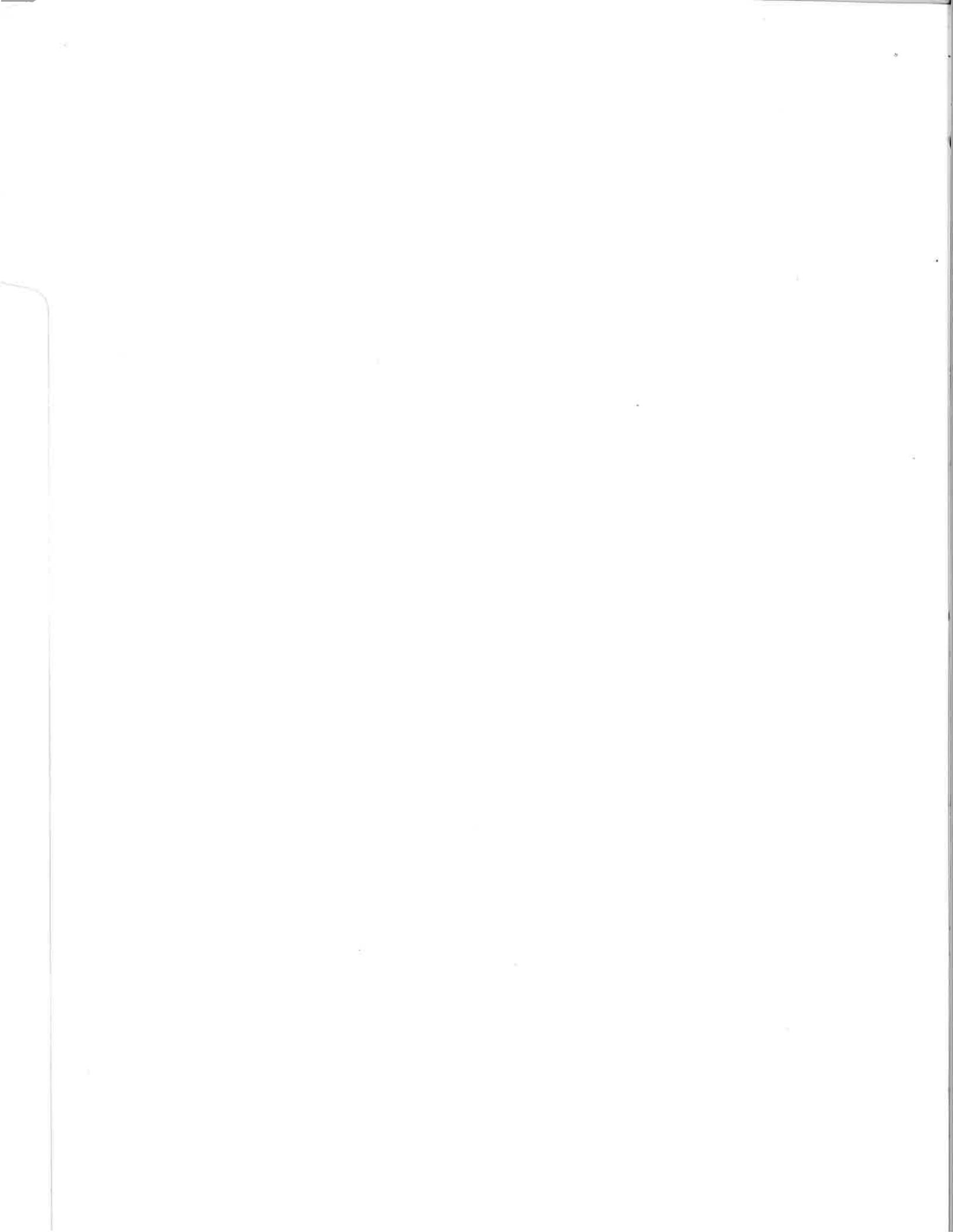
training sessions to customers' employees in glass stress analysis and control, break source analysis, and the interaction of fires on rework glass.

Inquiries for this service can be addressed to the Sales Manager, your Sales Representative, or the Manager of Sales Engineering, all located in Greenland, New Hampshire.



Lead Alkali Glass  
**Lead Alkali Glass**  
Lead Alkali Glass  
Lead Alkali Glass  
Lead Alkali Glass  
Lead Alkali Glass





# Lead Alkali Glass

# SG 10

## Introduction

SG 10 is a potash soda lead glass which can be sealed with our soda lime glass and other glasses of similar expansion.

## Applications

This glass is used extensively in the lamp industry, primarily for photoflash and circline lamps as well as in the electronic industry.

## Availability

Machine drawn tubing (both long length and cut length) and circline fluorescent tubing.

## Physical Properties

### Mechanical:

Density:	2.86g/cm <sup>3</sup>
Young's Modulus:	6.24 × 10 <sup>3</sup> kg/mm <sup>2</sup> (8.9 × 10 <sup>6</sup> psi)
Poisson's Ratio:	.21
Shear Modulus:	2.6 × 10 <sup>3</sup> kg/mm <sup>2</sup> (3.7 × 10 <sup>6</sup> psi)
Knoop Hardness:	360

### Viscosity:

Working Point	985°C
Softening Point	628 ± 5°C
Annealing Point	432 ± 5°C
Strain Point	392°C

### Thermal Expansion:

Coef. of Exp. (× 10 <sup>-7</sup> /°C)	93.1 ± 1.7
Room Temp/S.P.(× 10 <sup>-7</sup> /°C)	99.8

### Optical:

Index of Refraction	1.539
Birefringence Constant	306 (nm/cm) (kg/mm <sup>2</sup> )

### Electrical:

Log <sub>10</sub> Volume Resistivity	
@ 250°C	8.9 Ω cm
@ 350°C	7.0 Ω cm
Loss Tangent @ 20°C	.16%
Dielectric Constant	6.7

Key properties: softening point, anneal point and expansion are controlled within specified tolerances to insure a compatible sealing glass. The values given for the other properties are typical, however, the deviation from these values would be small since composition must be held very precisely to maintain the control of the key properties.

### Typical Chemical Composition

SiO <sub>2</sub>	: 61.0%
PbO	: 21.5%
Na <sub>2</sub> O	: 7.7%
K <sub>2</sub> O	: 7.45%
Al <sub>2</sub> O <sub>3</sub>	: 2.1%
As <sub>2</sub> O <sub>3</sub>	: 0.15%
CaO	: 0.10%

### Length

Standard length drawn tubing between .200" and 1.000" in diameter is normally trimmed and glazed to 48" ± 1/8". For diameters .300" or above, 56" lengths are also available. For diameters less than .200" and greater than 1.000", the tubing is normally supplied rough cut 47 3/4" ± 1" in length.

Normal tolerances for cut tubing vary according to diameter. Exhaust tubing less than or equal to .230" in diameter has a normal tolerance of ± .030". Sizes ranging from .231" to .400" are usually provided with tolerances of ± .020".

Circline fluorescent tubing, T9 and T10, is held to a baseline tolerance of ± .015".

### Packaging

The amount of glass packed in a tote box will vary depending on O.D., wall thickness and length. The standard method of packing SG 10 glass includes a horizontal tote box pack for standard length drawn tubing which usually averages from 800 to 1400 pounds.

Cut tubing is normally supplied in individual boxes averaging 15 to 30 pounds each, then layer packed, resulting in pallet weights of 1800 to 2400 pounds for diameters less than or equal to .230", and 800 to 1200 pounds for diameters of .231" to .400". Circline tubing is packed in a vertical pallet end cap type package.

All information pertaining to dimensions, tolerances and packaging is readily available, assuming normal O.D. to wall relationships. Specific requirements in any of these areas may be requested.

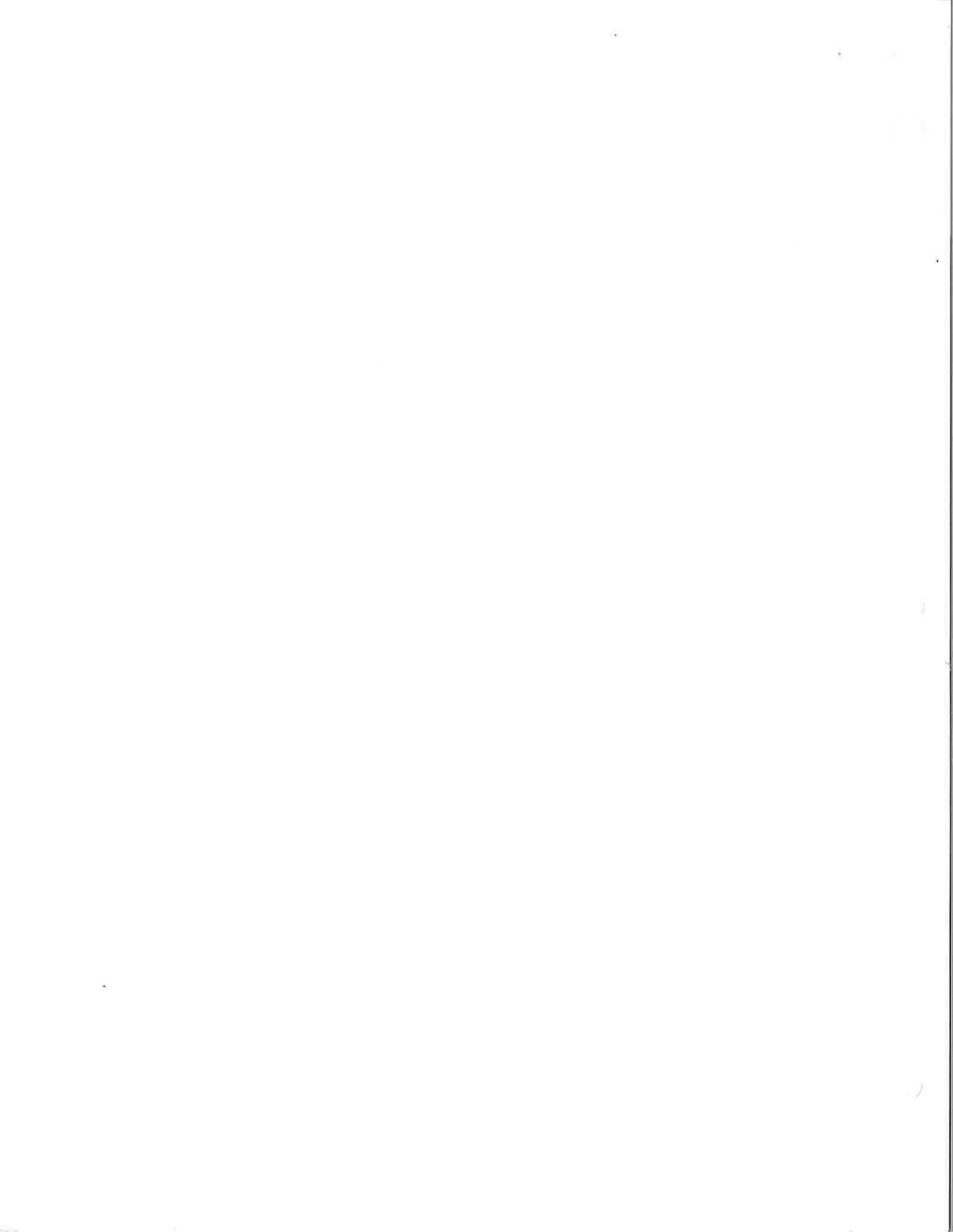
### Dimensional Capabilities

Nominal O.D.	Tolerance	Out of Round
.067" to .114"	± .003"	.002"
.115" to .229"	± .004"	.002"
.230" to .440"	± .005"	.002"
.441" to .529"	± .006"	.003"
.530" to .629"	± .007"	.004"
.630" to .675"	± .009"	.004"
.676" to .870"	± .010"	.006"
.871" to 1.059"	± .014"	.007"
1.060" to 1.142"	± .015"	1% of nominal O.D.
1.143" to 1.500"	± .020"	1% of nominal O.D.

> 1.500" — Specifications and tolerances available upon request.

Nominal Wall Thickness	Tolerance	Siding
.018" to .030"	± .0015"	.0015"
.031" to .037"	± .0015"	.002"
.038" to .049"	± .002"	.002"
.050" to .065"	± .003"	.0035"
.066" to .080"	± .004"	.005"
.081" to .110"	± .005"	.006"

> .110" — Specifications and tolerances available upon request.



# Lead Alkali Glass

# SG 12

## Introduction

SG 12 is a potash soda lead glass higher in lead content than our SG 10 which can be sealed directly to our soda lime glass and other glasses of similar expansion.

## Applications

This glass possesses excellent flame working and electrical resistance properties necessary for lamp, valve, CRT and other electrical industries.

## Availability

Machine drawn tubing both long length and cut length.

## Physical Properties

### Mechanical:

Density:	3.05g/cm <sup>3</sup>
Young's Modulus:	6.0 × 10 <sup>3</sup> kg/mm <sup>2</sup> ( 8.6 × 10 <sup>6</sup> psi)
Poisson's Ratio:	.22
Shear Modulus:	2.5 × 10 <sup>3</sup> kg/mm <sup>2</sup> (3.5 × 10 <sup>6</sup> psi)

### Viscosity:

Working Point	985°C
Softening Point	630 ± 5°C
Annealing Point	435 ± 5°C
Strain Point	395°C

### Thermal Expansion:

Coef. of Exp. (× 10 <sup>-7</sup> /°C)	89.1 ± 1.5
Room Temp/S.P.(× 10 <sup>-7</sup> /°C)	99

### Optical:

Index of Refraction	1.560
Birefringence Constant	292 (nm/cm) (kg/mm <sup>2</sup> )

### Electrical:

Log <sub>10</sub> Volume Resistivity	
@ 250°C	10.1 Ω cm
@ 350°C	8.0 Ω cm
Loss Tangent @ 20°C	.12%
Dielectric Constant	6.7

Key properties: softening point, anneal point and expansion are controlled within specified tolerances to insure a compatible sealing glass. The values given for the other properties are typical, however, the deviation from these values would be small since composition must be held very precisely to maintain the control of the key properties.

## Typical Chemical Composition

SiO <sub>2</sub>	: 56.0%
PbO	: 29.4%
Na <sub>2</sub> O	: 4.4%
K <sub>2</sub> O	: 8.5%
Al <sub>2</sub> O <sub>3</sub>	: 1.4%
As <sub>2</sub> O <sub>3</sub>	: 0.2%
CaO	: 0.1%

## Length

Standard length drawn tubing between .200" and 1.000" in diameter is normally trimmed and glazed to 48" ± 1/8". For diameters .300" or above, 56" lengths are also available. For diameters less

than .200" and greater than 1.000", the tubing is normally supplied rough cut 47 3/4" ± 1" in length.

Normal tolerances for cut tubing vary according to diameter. Exhaust tubing, less than or equal to .230" in diameter, has a normal tolerance of ± .030". Sizes ranging from .231" to .400" are usually provided with tolerances of ± .020".

## Packaging

The amount of glass packed in a tote box will vary depending on the O.D., wall thickness and length. The standard method of packing SG 12 glass includes a horizontal tote box pack for standard length drawn tubing which usually averages from 800 to 1400 pounds.

Cut tubing is normally supplied in individual boxes averaging 15 to 30 pounds each, then layer packed, resulting in pallet weights of 1800 to 2400 pounds for diameters less than or equal to .230", and 800 to 1200 pounds for diameters of .231" to .400".

All information pertaining to dimensions, tolerances and packaging is readily available, assuming normal O.D. to wall relationships. Specific requirements in any of these areas may be requested.

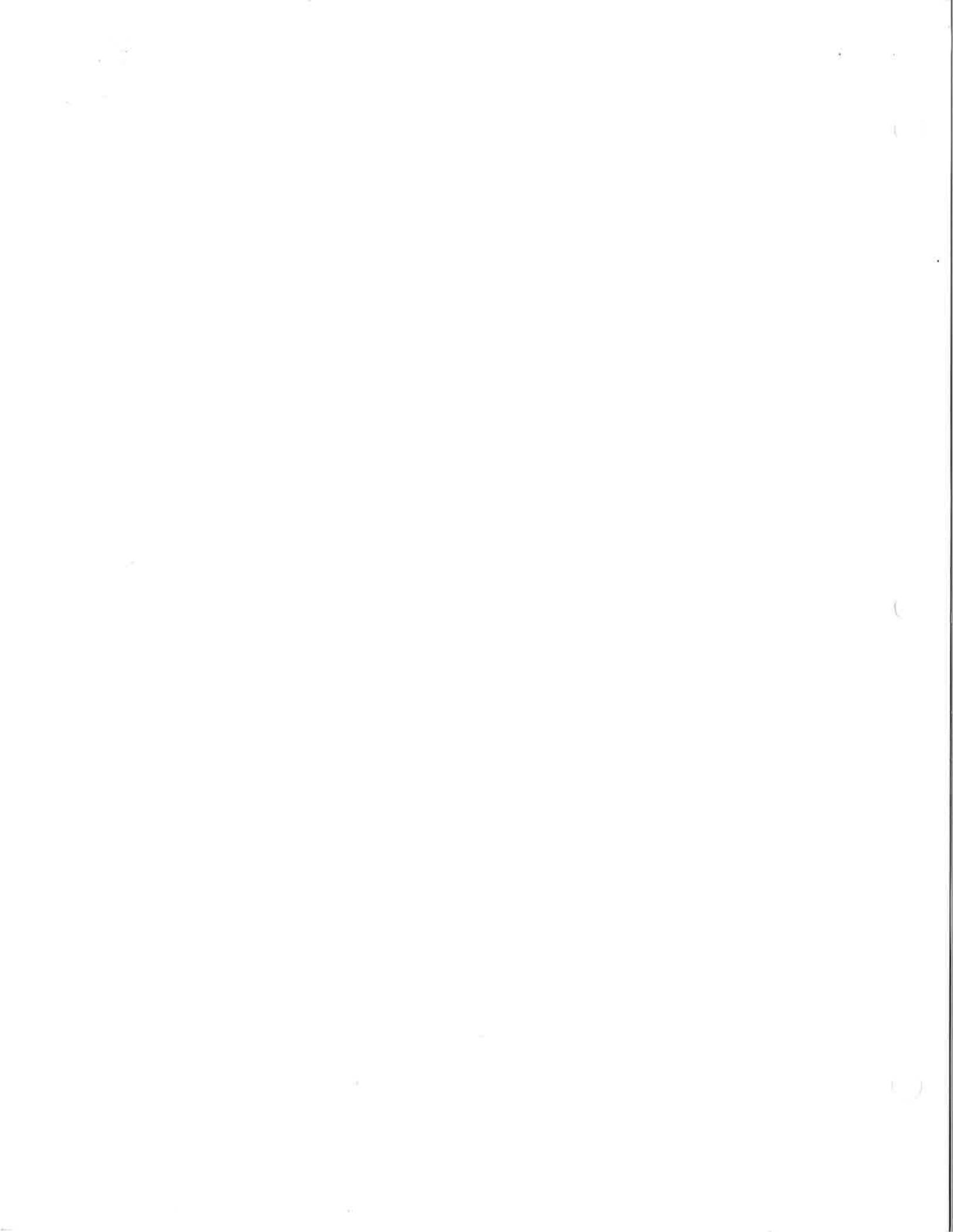
## Dimensional Capabilities

Nominal O.D.	Tolerance	Out of Round
.067" to .114"	± .003"	.002"
.115" to .229"	± .004"	.002"
.230" to .440"	± .005"	.002"
.441" to .529"	± .006"	.003"
.530" to .629"	± .007"	.004"
.630" to .675"	± .009"	.004"
.676" to .870"	± .010"	.006"
.871" to 1.059"	± .014"	.007"
1.060" to 1.142"	± .015"	1% of nominal O.D.
1.143" to 1.500"	± .020"	1% of nominal O.D.

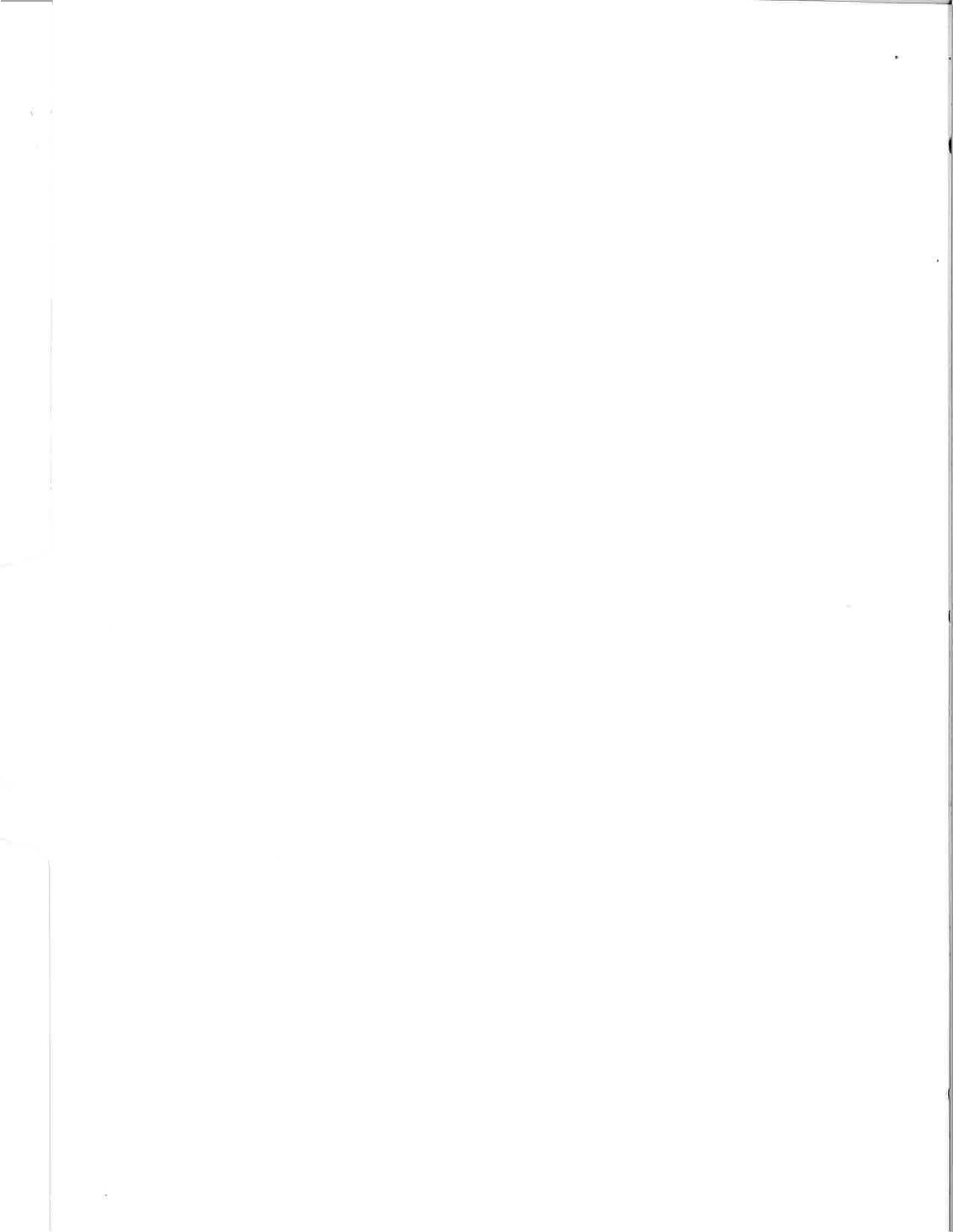
>1.500" — Specifications and tolerances available upon request.

Nominal Wall Thickness	Tolerance	Siding
.018" to .030"	± .0015"	.0015"
.031" to .037"	± .0015"	.002"
.038" to .049"	± .002"	.002"
.050" to .065"	± .003"	.0035"
.066" to .080"	± .004"	.005"
.081" to .110"	± .005"	.006"

>.110" — Specifications and tolerances available upon request.







## Introduction

SG 80 is a soda lime silicate (antimony fined). The glass seals satisfactorily to our standard SG 10 and SG 12 lead glasses and other glasses of similar expansion.

## Applications

This glass is used extensively for fluorescent lamp tubing, photoflash lamps and fiberglass applications.

## Availability

Standard length drawn tubing, fluorescent tubing and fiberglass pellets.

## Physical Properties

### Mechanical:

Density:	2.46g/cm <sup>3</sup>
Young's Modulus:	7.2 × 10 <sup>9</sup> kg/mm <sup>2</sup> (12.7 × 10 <sup>6</sup> psi)
Poisson's Ratio:	.22
Shear Modulus:	3.0 × 10 <sup>9</sup> kg/mm <sup>2</sup> (5.1 × 10 <sup>6</sup> psi)
Knoop Hardness:	465

### Viscosity:

Softening Point	700 ± 5°C
Annealing Point	514 ± 5°C
Strain Point	473°C

### Thermal Expansion:

Coef. of Exp. (× 10 <sup>-7</sup> /°C)	90.4 ± 1.5
Room Temp/S.P. (× 10 <sup>-7</sup> /°C)	104

### Optical:

Index of Refraction	1.512
Birefringence Constant	277 (nm/cm) (kg/mm <sup>2</sup> )

### Electrical:

Log <sub>10</sub> Volume Resistivity	
@ 250°C	6.4 Ω cm
@ 350°C	5.1 Ω cm
Loss Tangent @ 20°C	1.0%
Dielectric Constant	7.2

Key properties: softening point, anneal point and expansion are controlled within specified tolerances to insure a compatible sealing glass. The values given for the other properties are typical, however, the deviation from these values would be small since composition must be held very precisely to maintain the control of the key properties.

## Typical Chemical Composition

SiO <sub>2</sub>	: 73.71%
Na <sub>2</sub> O	: 16.4%
K <sub>2</sub> O	: 0.25%
CaO	: 4.8%
MgO	: 3.37%
Al <sub>2</sub> O <sub>3</sub>	: 1.3%
Sb <sub>2</sub> O <sub>3</sub>	: 0.17%

## Length

Standard length drawn tubing between .200" and .629" in diameter is normally trimmed and glazed to 48" ± 1/8". For

diameters .300" or above, 56" lengths are also available. For diameters less than .200", the tubing is normally supplied rough cut 47 3/4" ± 1" in length.

Fluorescent tubing (ends formed) both T-8 and T-12 sizes are available in lengths ranging from 13.8" to 92.8". Tolerances for baseline length are ± .015" or ± .020", depending on the size of the bulb with 40 Watt bulbs held to a tolerance of ± .012". Trimmed and glazed fluorescent tubing is normally held to an overall length of ± .030". T-14 1/2 bulbs are supplied trimmed and glazed in four sizes: 44.250", 56.250", 68.250" and 92.250", all with a standard tolerance of ± .0625".

## Dimensional Capabilities

(Standard Length Drawn Tubing)

Nominal O.D.	Tolerance	Out of Round
.067" to .114"	± .003"	.002"
.115" to .229"	± .004"	.002"
.230" to .440"	± .005"	.002"
.441" to .529"	± .006"	.003"
.530" to .629"	± .007"	.004"

Nominal Wall Thickness	Tolerance	Siding
.018" to .030"	± .0015"	.0015"
.031" to .037"	± .0015"	.002"
.038" to .049"	± .002"	.002"

## Dimensional Capabilities

(Fluorescent Tubing)

Size	Tolerance	Out of Round
T-8 (1.010")	± .015"	.015"
T-12 (1.480")	± .015"	.015"
T-14 1/2 (1.826")	± .030"	.030"

NOTE: T-8 and T-12 fluorescent tubing is normally supplied with an All Points In wall thickness of .029" to .035" and T-14 1/2 a wall of .035" to .043".

## Packaging

Length		Pieces/Pallet
13.8" to 19.9" 21.0" to 21.9" 22.0" to 35.0" 46.8" to 92.8"	T-8	4320
		2160
		2268
		1701
13.8" 16.8" to 22.8" 23.0" to 46.8" 52.8" to 92.8"	T-12	3402
		2268
		1134
		864
All sizes	T-14 1/2	504

## Packaging

Standard methods of packing SG80 glass include a horizontal tote box pack for standard length drawn tubing and a vertical end cap and pallet pack for fluorescent tubing.

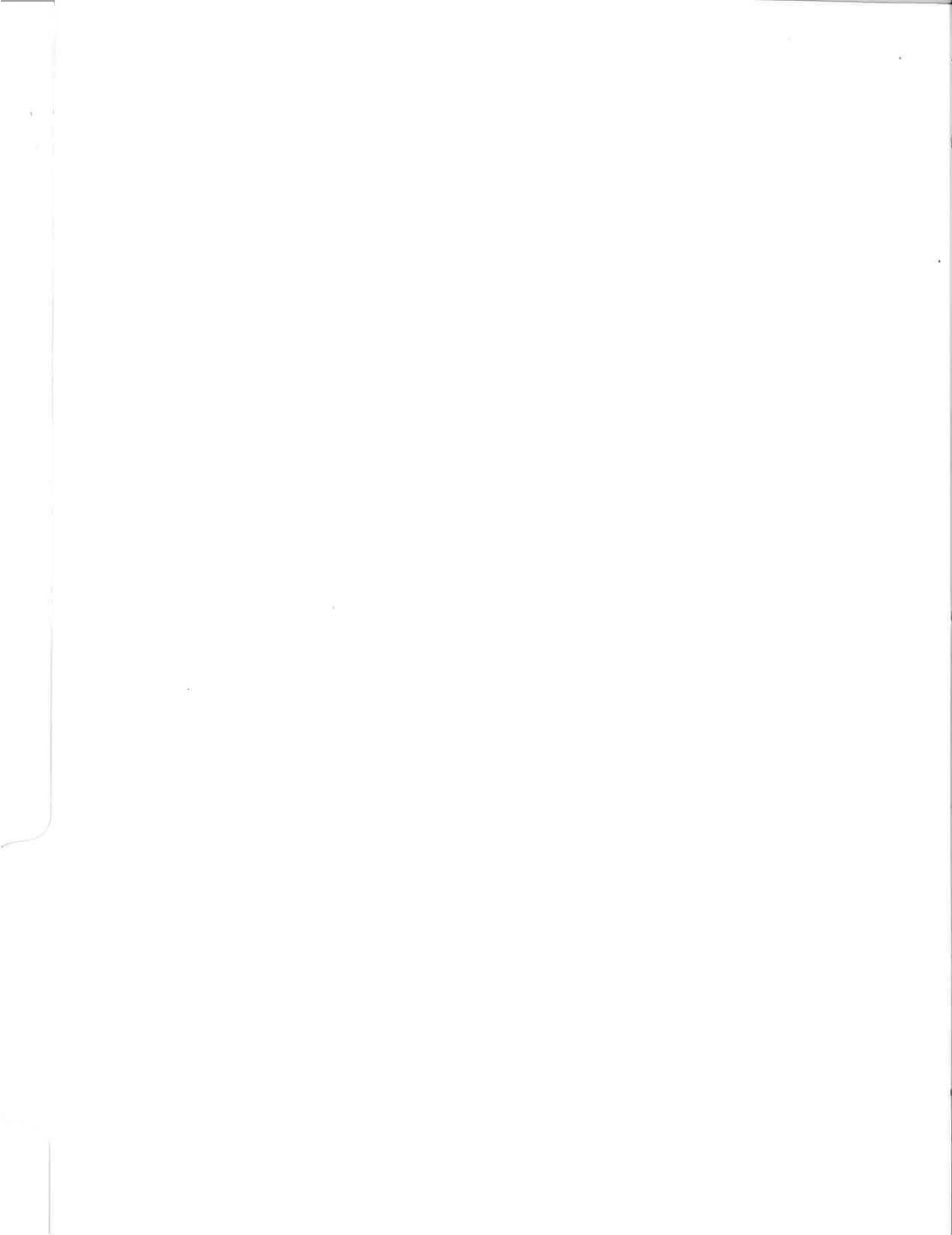
The amount of glass in a tote box will vary depending on O.D., wall thickness and length, but usually averages from 600 to 1300 pounds.

Pieces per pallet for fluorescent tubing is detailed below.

All information pertaining to dimensions, tolerances and packaging is readily available, assuming normal O.D. to wall relationships. Specific requirements in any of these areas may be requested.







# Soda Lime Glass Machine Made Bulbs

# SG 81

## Introduction

SG18 glass is a soda lime silicate. This glass is formulated to seal to the lead glasses used in stems and exhaust tubes, for example, SG10 and SG12.

## Applications

This glass is available in a variety of machine blown shapes used in incandescent lamps, electron tubes, ornaments, vacuum bottles, and lighting fixture glassware such as chimneys, shades, and globes. It is also available as tubing used in fluorescent lamps.

## Physical Properties

### Mechanical:

Density:	2.47g/cm <sup>2</sup>
Young's Modulus:	7.2 × 10 <sup>3</sup> kg/mm <sup>2</sup> (12.7 × 10 <sup>6</sup> psi)
Poisson's Ratio:	.22
Shear Modulus:	3.0 × 10 <sup>3</sup> kg/mm <sup>2</sup> (5.1 × 10 <sup>6</sup> psi)
Knop Hardness:	465

### Viscosity:

Working Point	1013°C
Softening Point	696° ± 5°C
Annealing Point	514° ± 5°C
Strain Point	473°C

### Thermal Expansion:

Coef. of Exp. (× 10 <sup>-7</sup> /°C)	93.5
Room Temp/S.P. (× 10 <sup>-7</sup> /°C)	104

### Expansion mismatch

with SG10	160 ppm less
with SG12	80 ppm less

### Optical:

Index of Refraction	1.51
Birefringence Constant	$\frac{277 \text{ (nm/cm)}}{\text{(kg/mm}^2\text{)}}$

### Electrical:

Log <sub>10</sub> Volume Resistivity	
@ 250°C	6.4 Ω cm
@ 350°C	5.1 Ω cm
Loss Tangent @ 20°C	1.0%
Dielectric Constant	7.33

Key properties: softening point, anneal point and expansion are controlled within specified tolerances to insure a compatible sealing glass. The values given for the other properties are typical, however, the deviation from these values would be small since composition must be held very precisely to maintain the control of the key properties.

### Typical Chemical Composition

SiO <sub>2</sub>	73%
Al <sub>2</sub> O <sub>3</sub>	1%
Na <sub>2</sub> O	17%
MgO	4%
CaO	5%

## Shape and Size Availability

In blown ware, light bulb shapes of A, B, G, GT, ER, P, PS, R, RD, RL, and T are made from available tooling sizes range from "20" (2½" at maximum diameter) to "52" (6.5" at maximum diameter). Residential lighting ware is available in chimney globes, shades, up to 8" in diameter. Other shapes can be manufactured with procurement of tooling up to 10" in diameter and 16" long.

## Bulb Finishing

Blown ware can be clear or inside chemically frosted. Frost densities can range from a #1 IF, used in "A" line lamps, to pale #4 IF, used in "Spot" reflector lamps. Bulbs can be stained, coated with a colored luster, or ceramic paint. Bulbs can also be metalized on the inside through a wet silver process or flashed aluminized.

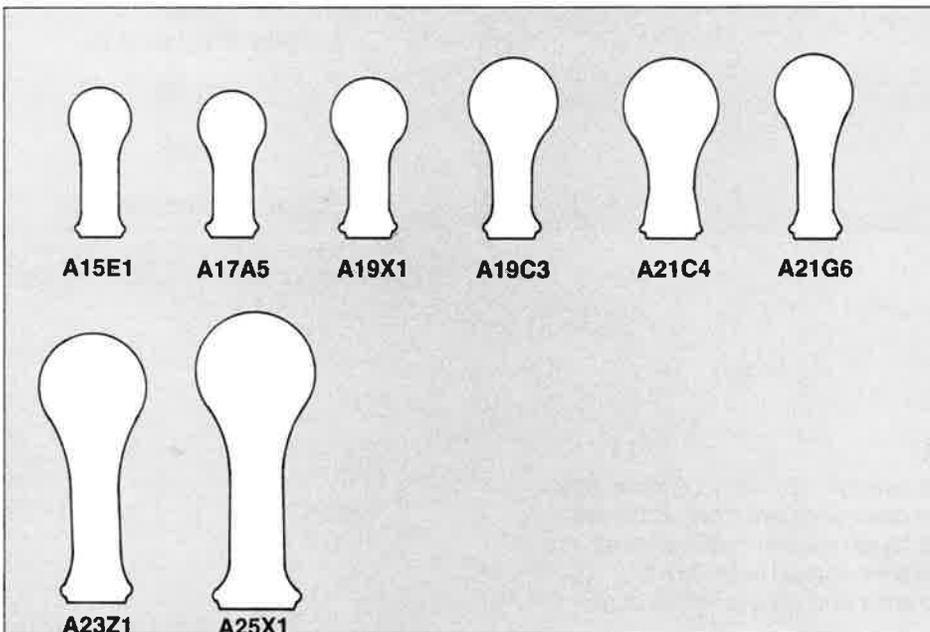
## Packaging

Blown ware can be packed bulk, tier, cell, or sleeve. Generally, the type of packing used is determined by the cost, size and fragility of the items. Bulk pack is the most dense, and least expensive, but is also least protective and has highest breakage. Cell pack is the least dense, most expensive and most protective. Standard packing options available on bulbs are listed on individual specifications along with count.

# Shape, Size, and Finishing Availability

# SG 81

## Shape



## Availability

# A

Size  
(eighths of an inch)  
15, 17, 19, 21, 23, 25

Finish

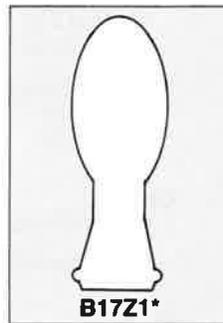
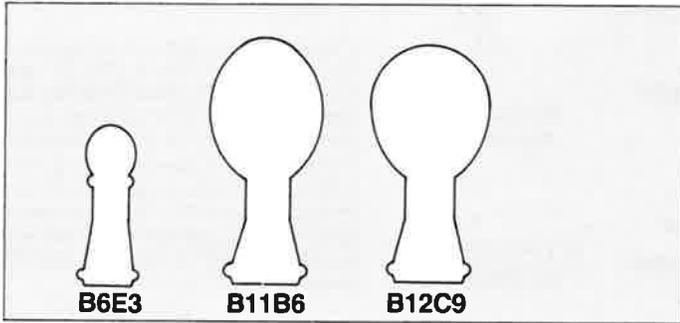
Clear, Frosted, Ceramic Coated\*

# Shape, Size, and Finishing Availability

# SG 81

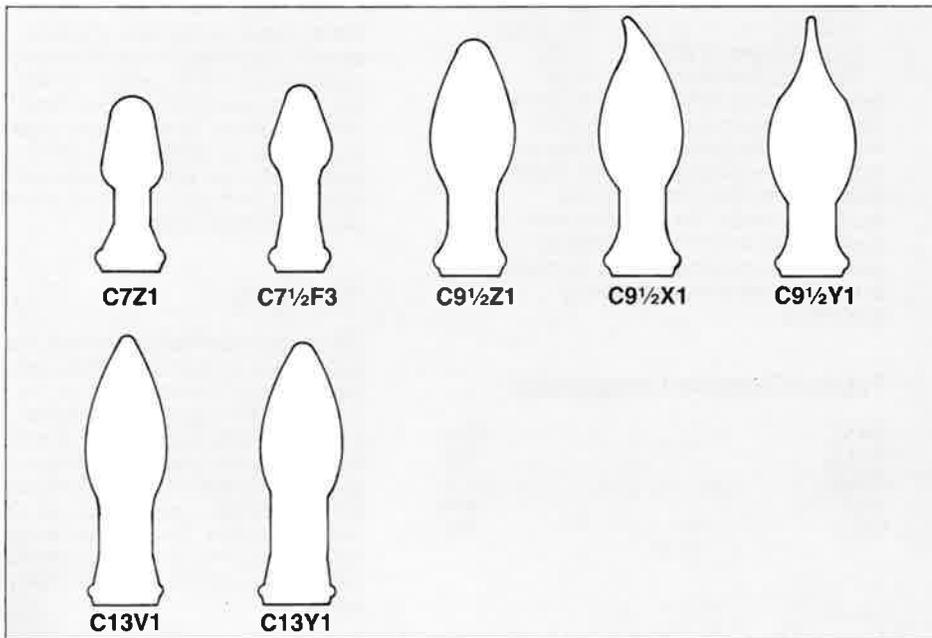
## Shape

## Availability

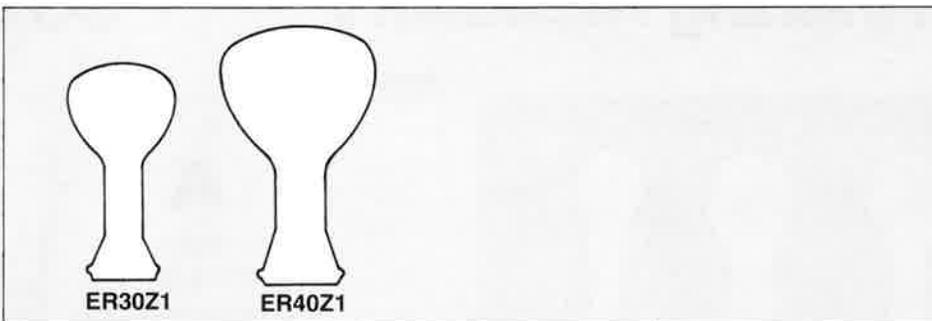


\*Not shown to scale of bulbs in left-hand block.

**B**  
 Size  
 (eighths of an inch)  
 6, 11, 12, 17  
 Finish  
 Clear, Iridescent, Ceramic Coated\*



**C**  
 Size  
 (eighths of an inch)  
 7, 7½, 9½, 13  
 Finish  
 Clear, Frosted, Ceramic Coated\*



**ER**  
 Size  
 (eighths of an inch)  
 30, 40  
 Finish  
 Clear, Frosted, Silvered

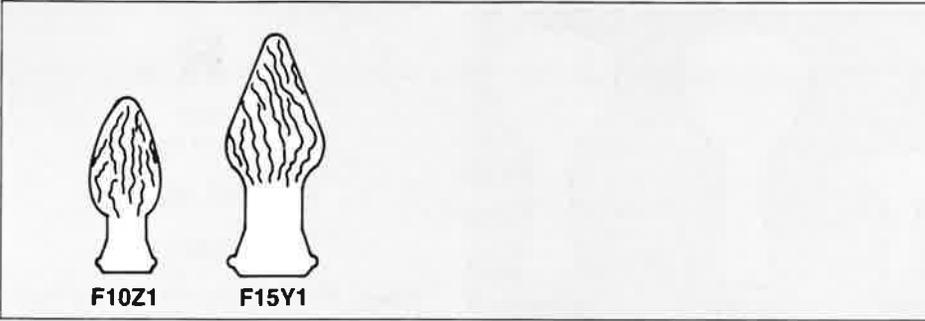
\*Ceramic coating colors include green, blue, orange, red, white, yellow, pink, rose, flame and ivory. Various tones of these colors are available. Different bulb shapes have a standard wipe length although specific requirements other than standard can be produced. All ceramic coated bulbs are tier packed. Specific information with respect to color and wipe length is available upon request.

# Shape, Size, and Finishing Availability

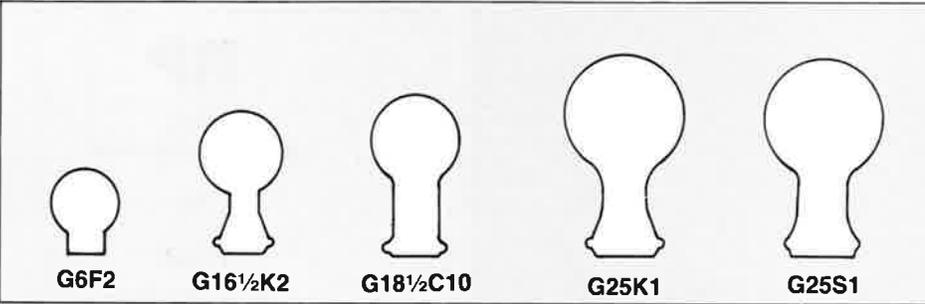
# SG 81

Shape

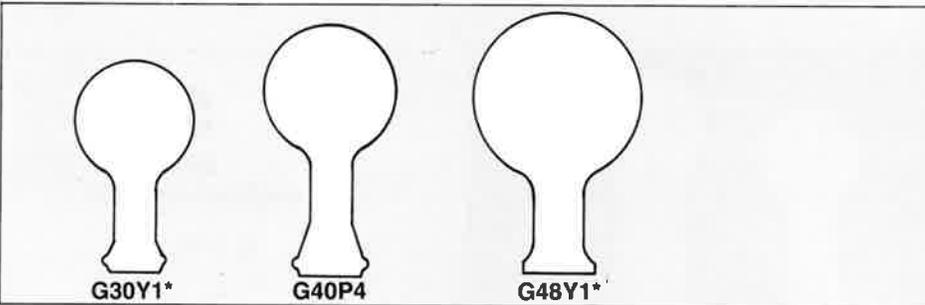
Availability



**F**  
 Size  
 (eighths of an inch)  
 10, 15  
 Finish  
 Clear, Frosted, Ceramic Coated\*,  
 Iridescent



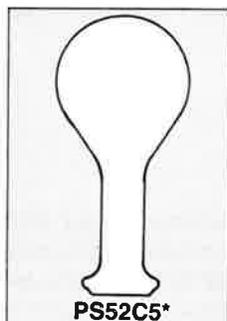
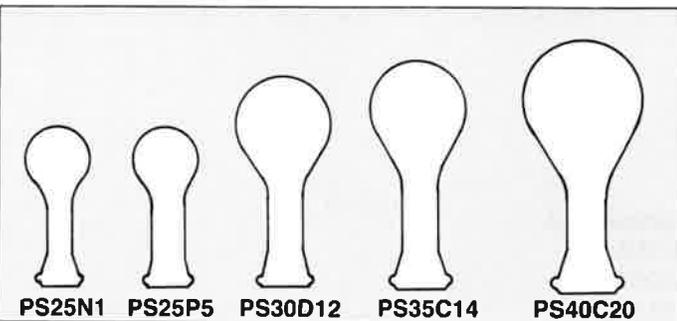
**G**  
 Size  
 (eighths of an inch)  
 6, 16½, 18½, 25, 30, 40, 48  
 Finish  
 Clear, Frosted, Ceramic Coated\*



\*Not shown to scale of bulbs in upper block of "G" Series.



**P**  
 Size  
 (eighths of an inch)  
 25  
 Finish  
 Clear, Frosted



**PS**  
 Size  
 (eighths of an inch)  
 25, 30, 35, 40, 52  
 Finish  
 Clear, Frosted, Bowl Silvered

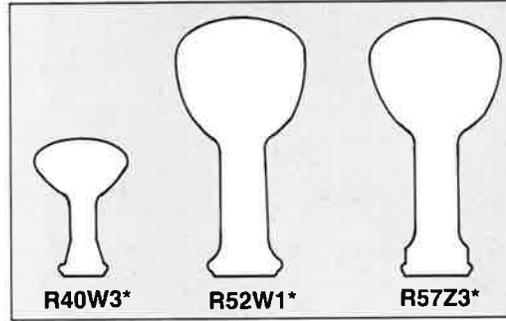
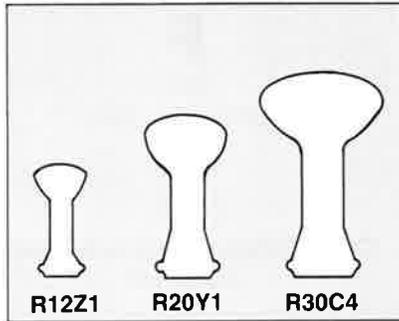
\*Not shown to scale of bulbs in left-hand block.

# Shape, Size, and Finishing Availability

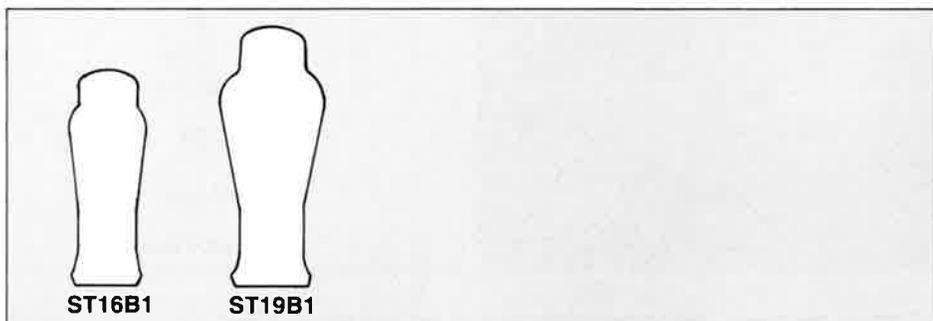
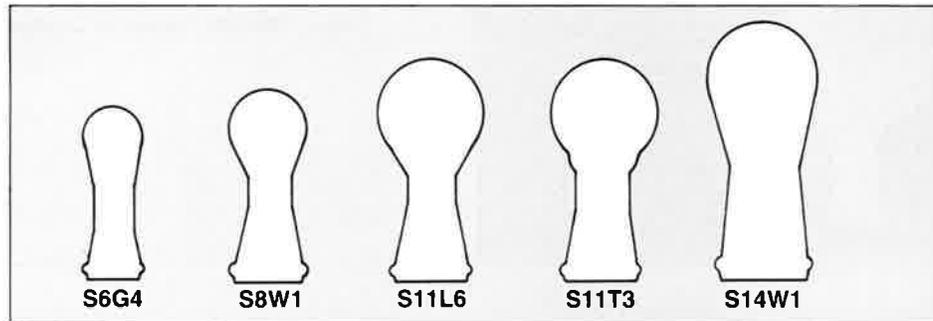
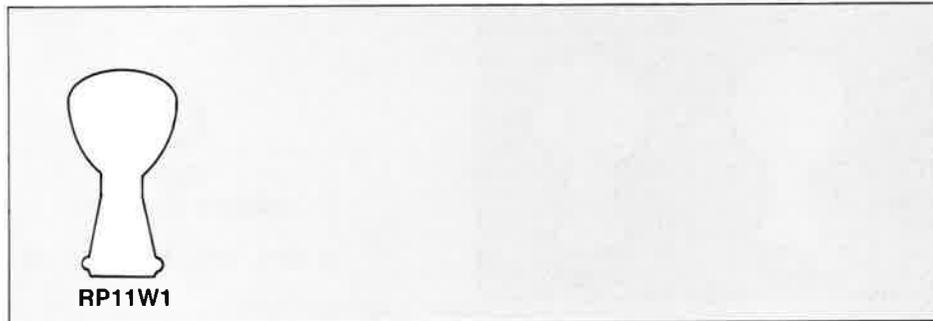
# SG 81

## Shape

## Availability



*\*Not shown to scale of bulbs in left-hand block.*



## R

Size  
(eighths of an inch)

12, 20, 30, 40, 52, 57

Finish

Clear, Frosted, Neck Silvered, Painted

## RP

Size  
(eighths of an inch)

11

Finish

Clear, Frosted

## S

Size  
(eighths of an inch)

6, 8, 11, 14

Finish

Clear, Frosted, Ceramic Coated\*

## ST

Size  
(eighths of an inch)

16, 19

Finish

Clear

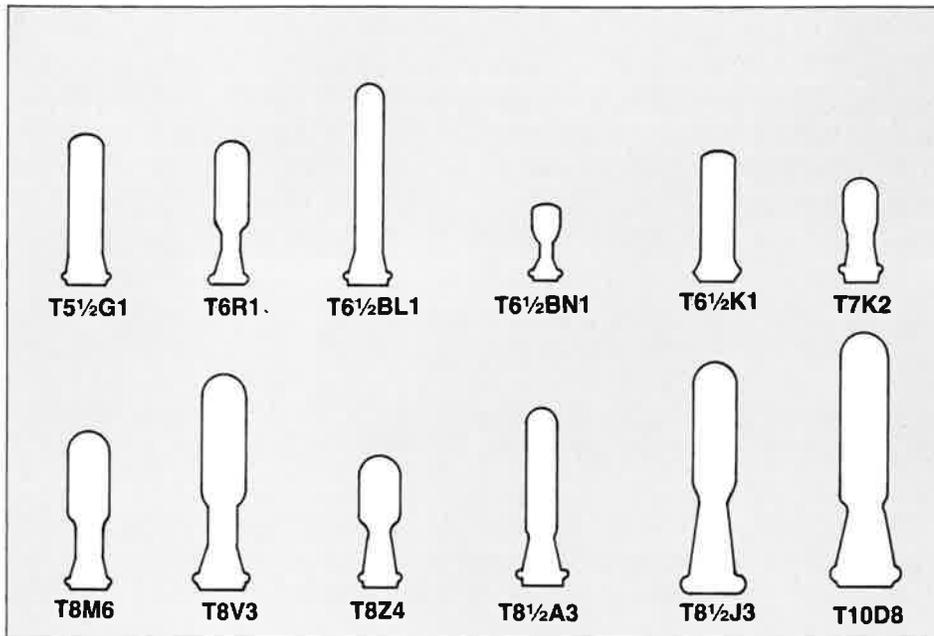
\*Ceramic coating colors include green, blue, orange, red, white, yellow, pink, rose, flame and ivory. Various tones of these colors are available. Different bulb shapes have a standard wipe length although specific requirements other than standard can be produced. All ceramic coated bulbs are tier packed. Specific information with respect to color and wipe length is available upon request.

# Shape, Size, and Finishing Availability

# SG 81

Shape

Availability



## T

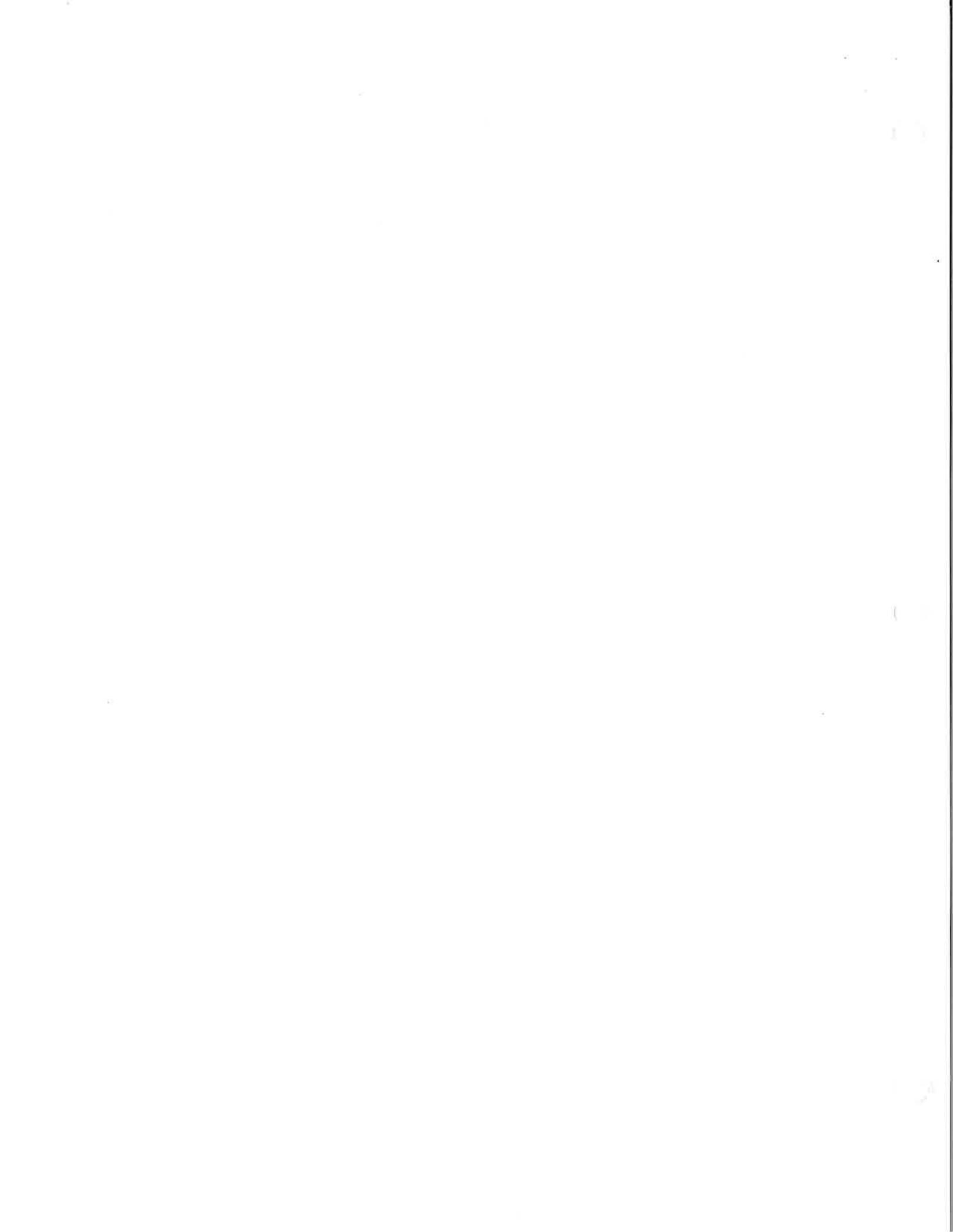
Size  
(eighths of an inch)

5½, 6, 6½, 7, 8, 8½, 10

Finish

Clear, Frosted, Ceramic Coated\*

\*Ceramic coating colors include green, blue, orange, red, white, yellow, pink, rose, flame and ivory. Various tones of these colors are available. Different bulb shapes have a standard wipe length although specific requirements other than standard can be produced. All ceramic coated bulbs are tier packed. Specific information with respect to color and wipe length is available upon request.



# Soda Lime Glass

# SG 81 SG 91

## Introduction

SG-81 and SG-91 glasses are soda lime silicates. Both glasses are formulated to seal to the lead glasses used in stems and exhaust tubes; for example: SG-10 and SG-12.

SG-81 is soda lime glass manufactured at GTE's Central Falls, RI, plant. SG-81 glass is available for fluorescent bulbs as well as blown bulbs.

SG-91 is a more durable soda lime glass, manufactured at GTE's Wellsboro, PA, plant. SG-91 is available in blown bulb configurations only.

## Applications

These glasses are available in a variety of machine-blown shapes used in incandescent lamps, electron tubes, ornaments, vacuum bottles, and lighting fixture glassware such as chimneys, shades, and globes. They are also available as tubing used in fluorescent lamps.

## Bulb Finishing

Blown ware can be clear or inside-chemically-frosted. Frost densities can range from a #1 IF, used in "A" line lamps, to pale #4 IF, used in "Spot" reflector lamps. Bulbs can be stained, or coated with a colored lustre or ceramic paint. Bulbs can also be metalized on the inside through a wet silver process or flashed-aluminized.

## Packaging

Blown ware can be packed bulk, tier, cell or sleeve. Generally, the type of packing used is determined by the cost, size and fragility of the items. Bulk pack is the most dense, and least expensive, but is also least protective and has highest breakage. Cell pack is the least dense, most expensive and most protective. Standard packing options available on bulbs are listed on individual specifications along with count.

## Physical Properties

### Mechanical:

	SG 81	SG 91
Density:	2.47g/cm <sup>3</sup>	2.48g/cm <sup>3</sup>
Young's Modulus:	7.2 × 10 <sup>9</sup> kg/mm <sup>2</sup> (12.7 × 10 <sup>6</sup> psi)	
Poisson's Ratio:	.22	
Shear Modulus:	3.0 × 10 <sup>9</sup> kg/mm <sup>2</sup> (5.1 × 10 <sup>6</sup> psi)	
Knoop Hardness:	465	
Viscosity:		
Working Point	1013°	
Softening Point	696° ± 5°C	705° ± 5°C
Annealing Point	514° ± 5°C	523° ± 5°C
Strain Point	473°C	485°C

### Thermal Expansion:

Coef. of Exp. (× 10 <sup>-7</sup> /°C)	93.5
Room Temp/S.P. (× 10 <sup>-7</sup> /°C)	104

Expansion mismatch with SG10	160 ppm less
with SG12	80 ppm less

### Optical:

Index of Refraction	1.51
Birefringence Constant	277 (nm/cm) (kg/mm <sup>2</sup> )

### Electrical:

Log <sub>10</sub> Volume Resistivity @ 250°C	6.4 cm
@ 350°C	5.1 cm
Loss Tangent @ 20°C	1.0%
Dielectric Constant	7.33

## Key Properties (SG 81 & SG 91):

Softening point, anneal point and expansion are controlled within specified tolerances to insure a compatible sealing glass. The values given for the other properties are typical; however, the deviation from these values would be small, since composition must be held very precisely to maintain the control of the key properties.

## Typical Chemical Composition

	SG 81	SG 91
SiO <sub>2</sub>	73.0%	73.3%
Al <sub>2</sub> O <sub>3</sub>	1.0%	1.4%
Na <sub>2</sub> O	17.0%	15.4%
MgO	4.0%	3.9%
CaO	5.0%	5.6%
K <sub>2</sub> O	0.0%	0.2%

## Shape and Size Availability

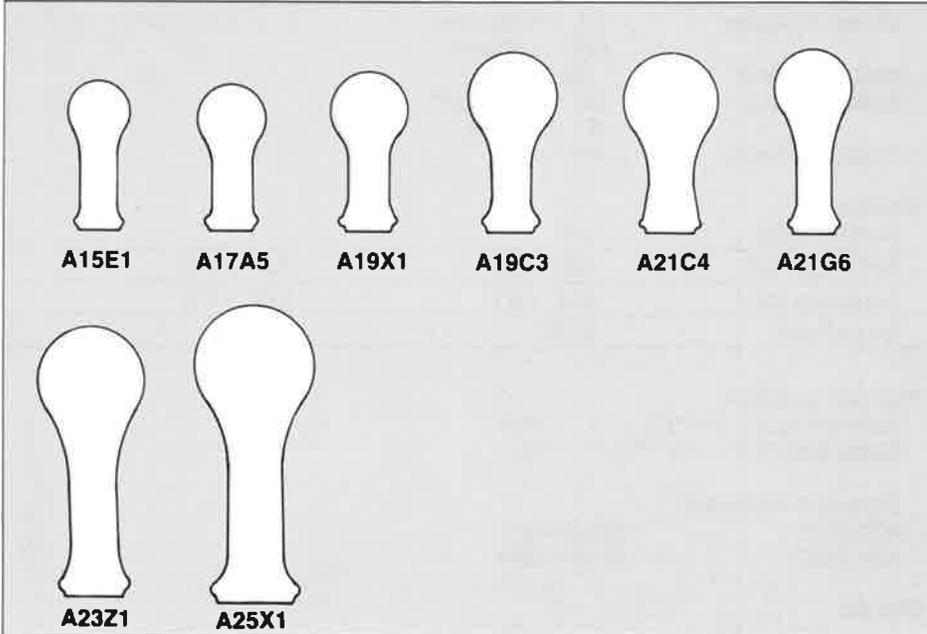
In SG-81 blown ware, light bulb shapes of A, G, GT, ER, P, PS, R, and T are made from available tooling sizes ranging from "20" (2½" at maximum diameter) to "52" (6.5" at maximum diameter.) Residential lighting ware is available in chimney globes and shades up to 8" in diameter. Other shapes can be manufactured with procurement of tooling up to 10" in diameter and 16" long. For actual sizes within each shape category, refer to GTE general specifications.

In SG-91 blown ware, bulb shapes readily available include "A", "B", "C", "F", "G", "R", "RP", "S", "ST", and "T", types, ranging in diameters from .688" to 2.875". For exact combinations of shape and size available, refer to accompanying charts in this catalog.

# Shape, Size, and Finishing Availability

**SG 81**  
**SG 91**

## Shape



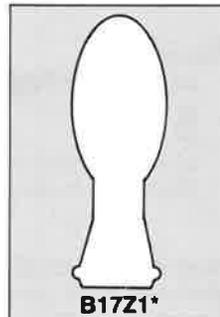
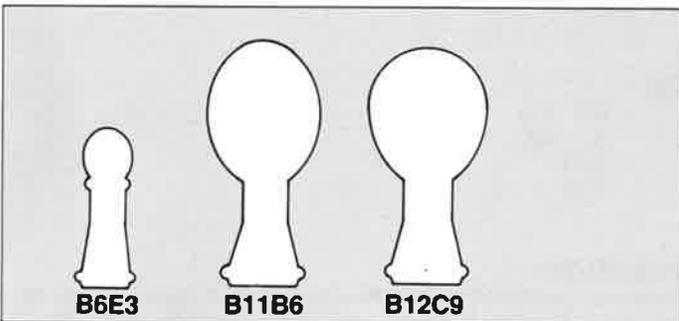
## Availability

**A**

Size  
(eighths of an inch)  
15, 17, 19, 21, 23, 25

Finish

Clear, Frosted, Ceramic Coated\*



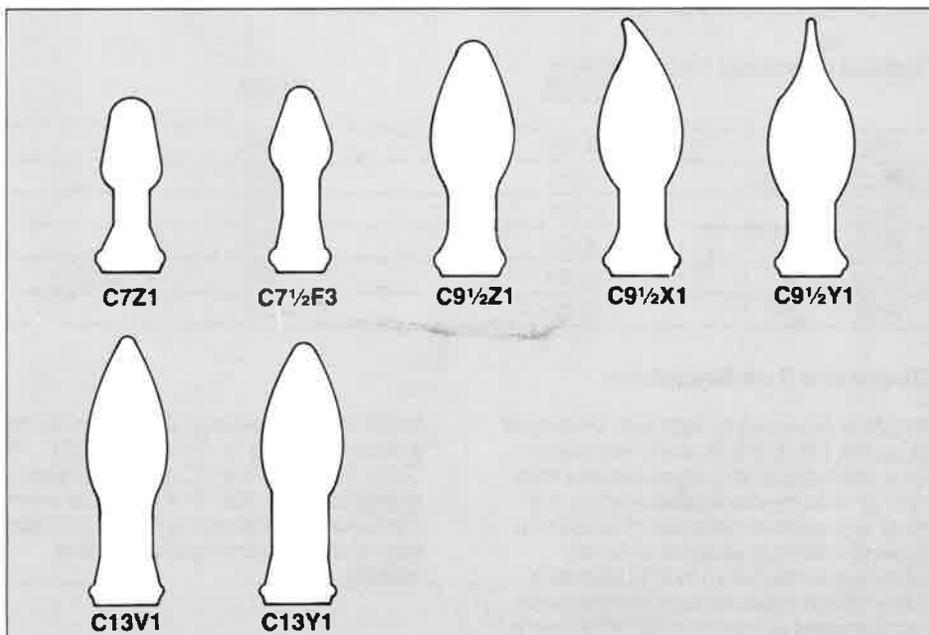
**B**

Size  
(eighths of an inch)  
6, 11, 12, 17

Finish

Clear, Iridescent, Ceramic Coated\*

\*Not shown to scale of bulbs in left-hand block.



**C**

Size  
(eighths of an inch)  
7, 7½, 9½, 13

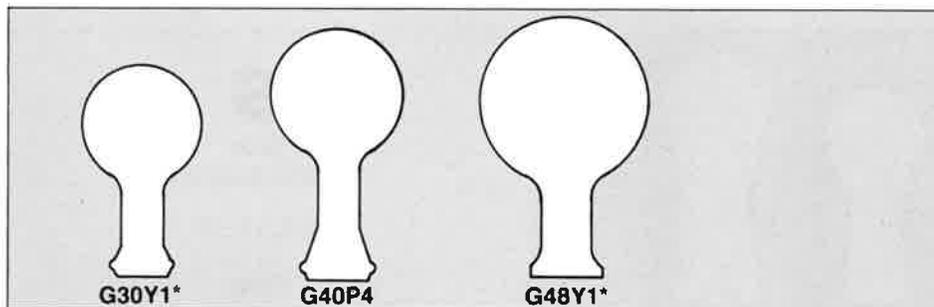
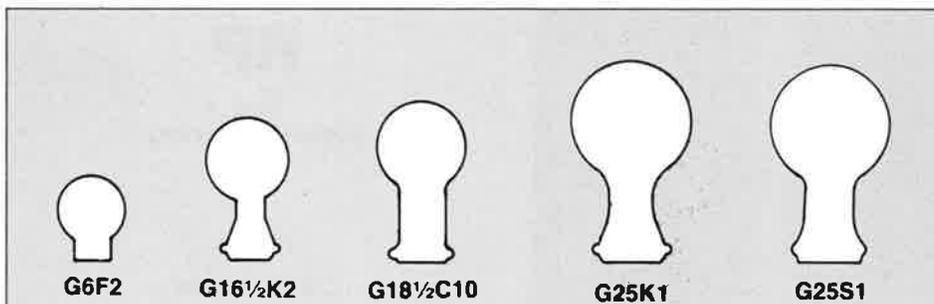
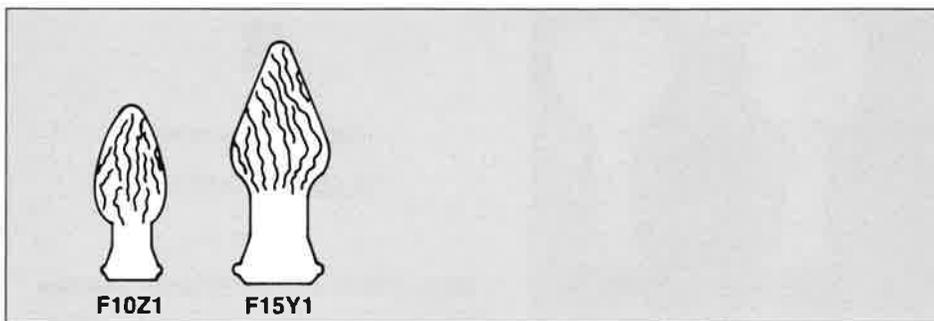
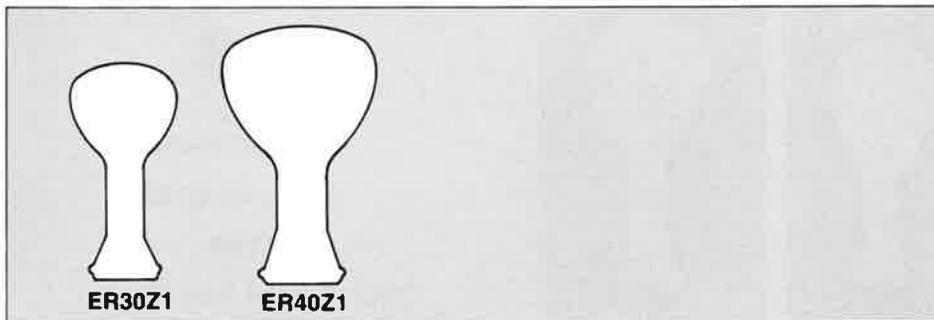
Finish

Clear, Frosted, Ceramic Coated\*

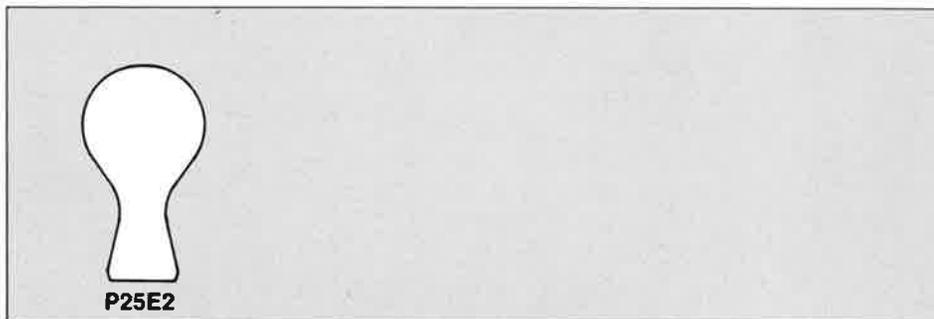
# Shape, Size, and Finishing Availability

**SG 81**  
**SG 91**

## Shape



*\*Not shown to scale of bulbs in upper block of "G" Series.*



## Availability

**ER**

Size  
(eighths of an inch)

30, 40

Finish

Clear, Frosted, Silvered

**F**

Size  
(eighths of an inch)

10, 15

Finish

Clear, Frosted, Ceramic Coated\*,  
Iridescent

**G**

Size  
(eighths of an inch)

6, 16½, 18½, 25, 30, 40, 48

Finish

Clear, Frosted, Ceramic Coated\*

**P**

Size  
(eighths of an inch)

25

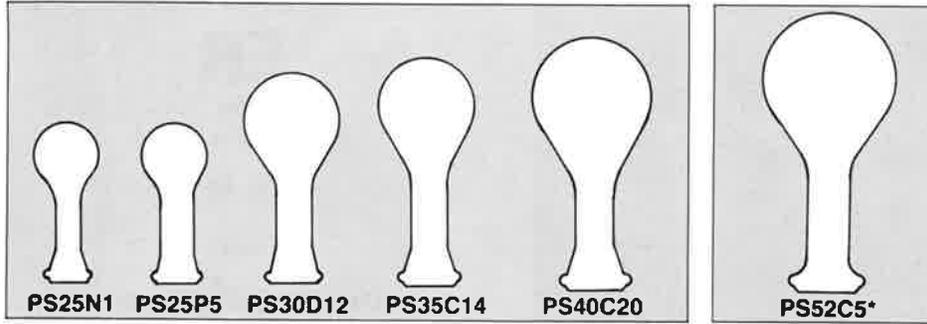
Finish

Clear, Frosted

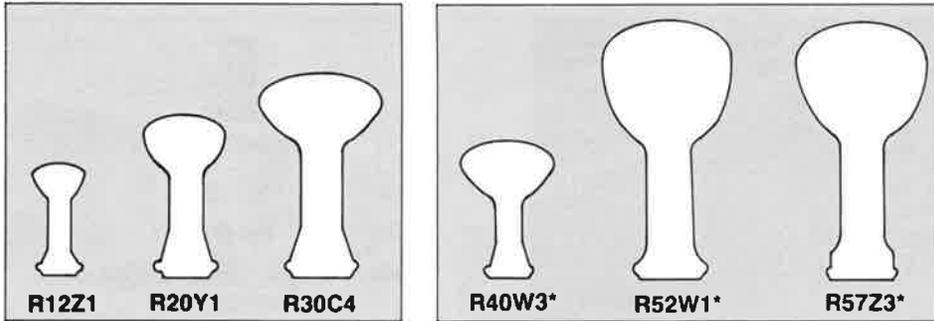
# Shape, Size, and Finishing Availability

# SG 81 SG 91

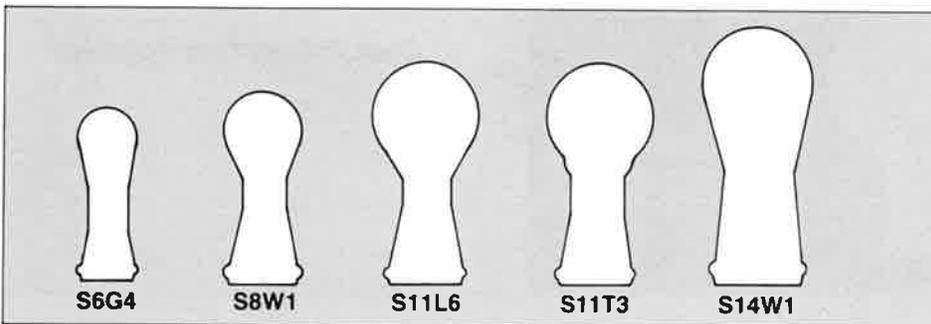
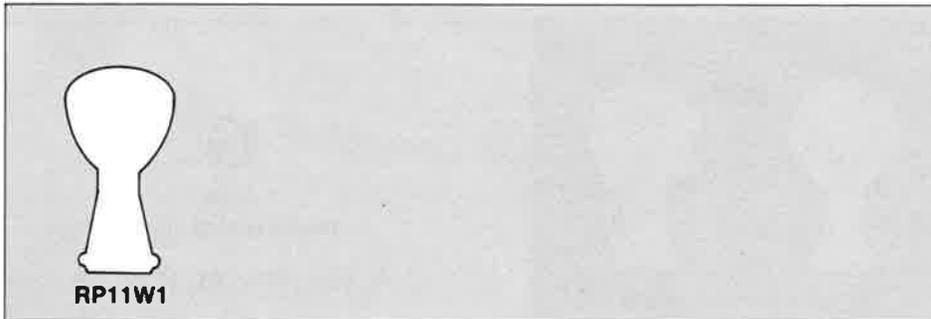
## Shape



\*Not shown to scale of bulbs in left-hand block.



\*Not shown to scale of bulbs in left-hand block.



## Availability

### PS

Size  
(eighths of an inch)

25, 30, 35, 40, 52

Finish

Clear, Frosted, Bowl Silvered

### R

Size  
(eighths of an inch)

12, 20, 30, 40, 52, 57

Finish

Clear, Frosted, Neck Silvered, Painted

### RP

Size  
(eighths of an inch)

11

Finish

Clear, Frosted

### S

Size  
(eighths of an inch)

6, 8, 11, 14

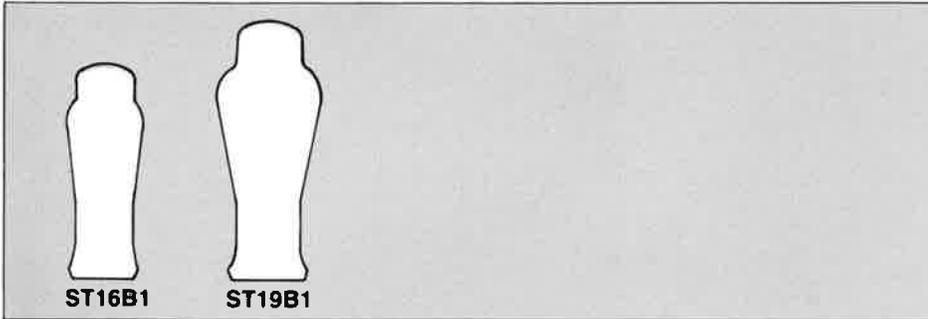
Finish

Clear, Frosted, Ceramic Coated\*

# Shape, Size, and Finishing Availability

**SG 81**  
**SG 91**

## Shape



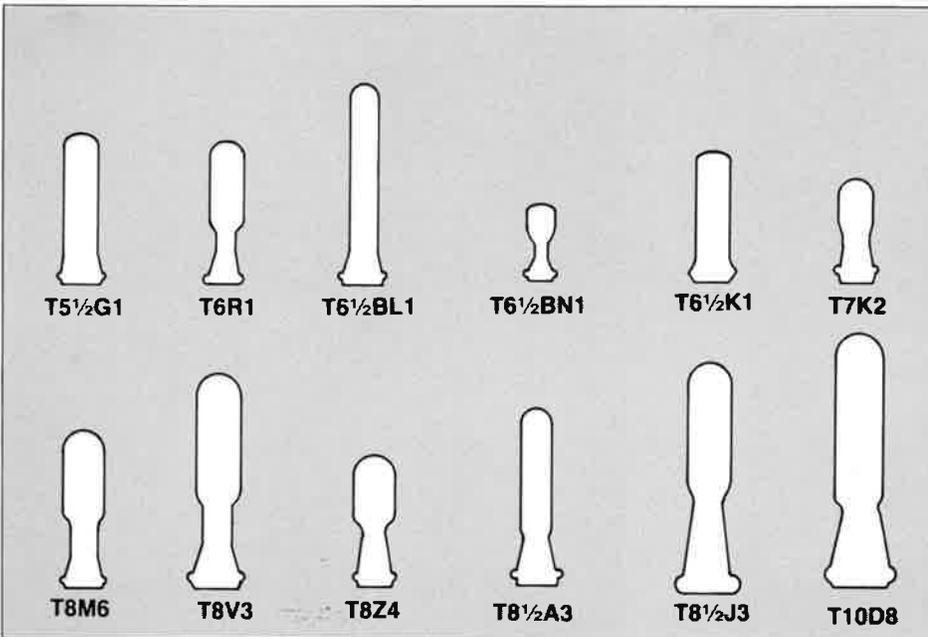
## Availability

**ST**

Size  
(eighths of an inch)

16, 19

Finish  
Clear



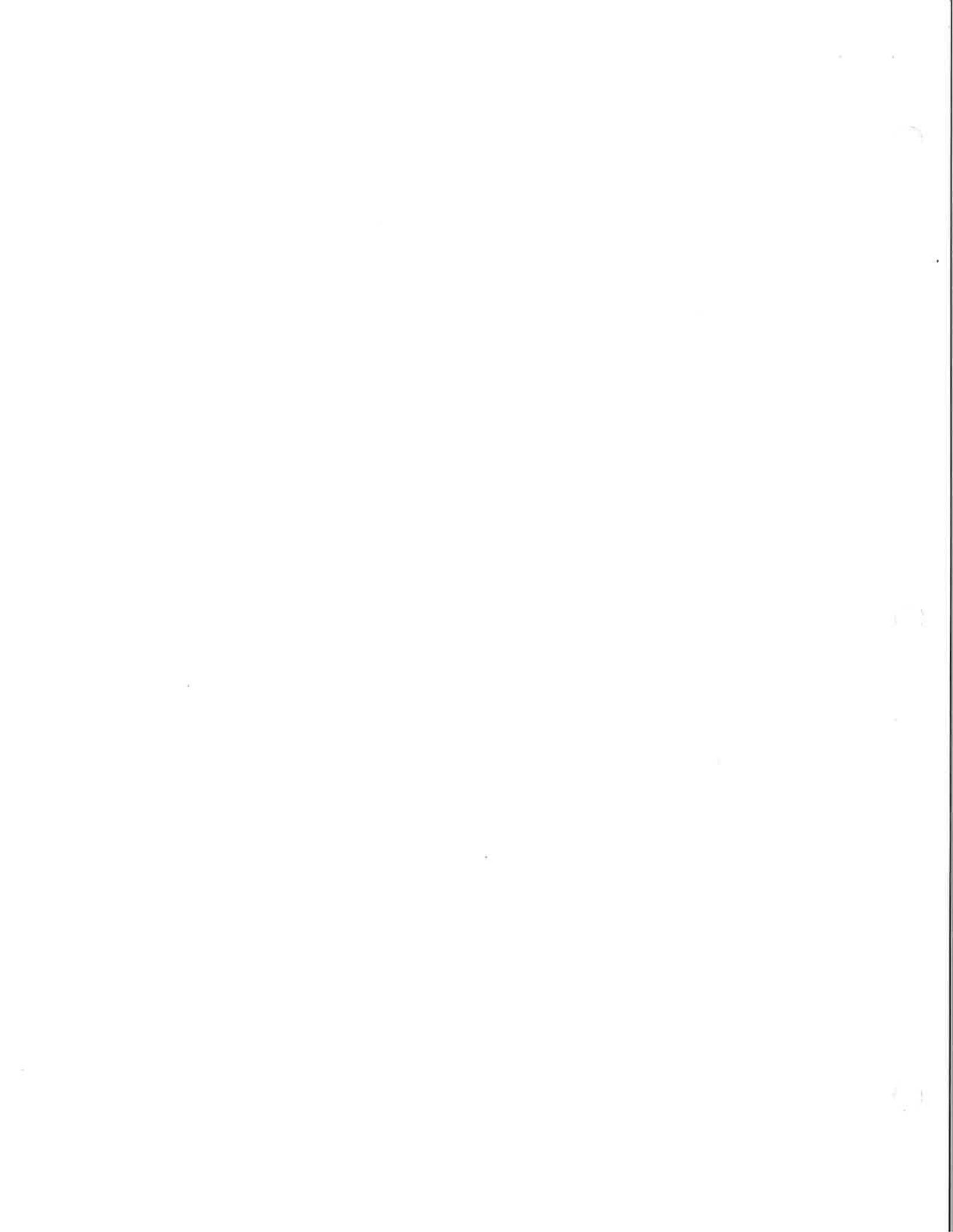
**T**

Size  
(eighths of an inch)

5½, 6, 6½, 7, 8, 8½, 10

Finish  
Clear, Frosted, Ceramic Coated\*

\*Ceramic coating colors include green, blue, orange, red, white, yellow, pink, rose, flame and ivory. Various tones of these colors are available. Different bulb shapes have a standard wipe length although specific requirements other than standard can be produced. All ceramic coated bulbs are tier packed. Specific information with respect to color and wipe length is available upon request.



# Borosilicate Glass

# SG 772

## Introduction

SG772 is a lead borosilicate. This glass is formulated to have the following advantages:

- Seal to tungsten wire
- Good weathering and chemical durability
- Good thermal shock resistance
- Blocks harmful UV radiation and x-ray radiation
- Resists solarization
- High resistivity

## Applications

This glass is currently available in a variety of machine blown shapes. These shapes are used for:

- HID lamp envelopes where it is resistant to solarization, blocking UV, and good weathering durability are utilized.
- Outdoor lamp envelopes where good thermal shock resistance is needed.
- Power tubes where radiation blocking, high resistivity, and tungsten sealability are needed.

## Physical Properties

### Mechanical:

Density:	2.35g/cm <sup>3</sup>
Young's Modulus:	6.3 × 10 <sup>3</sup> kg/mm <sup>2</sup> (9.0 × 10 <sup>6</sup> psi)
Poisson's Ratio:	.21
Shear Modulus:	2.6 × 10 <sup>3</sup> kg/mm <sup>2</sup> (3.6 × 10 <sup>6</sup> psi)

### Viscosity:

Working Point	1146°C
Softening Point	755° ± 5°C
Annealing Point	523° ± 5°C
Strain Point	484°C

### Thermal Expansion:

Coef. of Exp. (× 10 <sup>-7</sup> /°C)	36 + 1.5
Room Temp/S.P. (× 10 <sup>-7</sup> /°C)	41

Expansion mismatch with tungsten	120 ppm greater
with 3320	90 ppm greater
with 7720	0 ppm

### Optical:

Index of Refraction	1.487
Birefringence Constant	$\frac{360 \text{ (nm/cm)}}{\text{(kg/mm}^2\text{)}^{-1}}$
Transmittance @ 280 nm thru 1 mm	<1%

### Electrical:

Log <sub>10</sub> Volume Resistivity @ 250°C	8.8 Ω cm
@ 350°C	7.3 Ω cm
Loss Tangent @ 20°C	.23%
Dielectric Constant	4.6

Key properties: softening point, anneal point and expansion are controlled within specified tolerances to insure a compatible sealing glass. The values given for the other properties are typical, however, the deviation from these values would be small since glass composition must be held very precisely to maintain the control of the key properties.

## Typical Chemical Composition

SiO <sub>2</sub>	73%
Al <sub>2</sub> O <sub>3</sub>	1%
B <sub>2</sub> O <sub>3</sub>	15%
Na <sub>2</sub> O	4%
PbO	6%
Trace Oxides	1%

## Shape and Size Availability:

Bulb shapes of the following are available from existing tooling. A, B, BT, G, ED, G, GT, PS, R, RD, RL, and T. Sizes range from "23" (2.875") to "80" (10.00"). Other shapes can be manufactured with procurement of tooling up to 10" in diameter and 16" long.

## Bulb Finishing

Bulb can be clear or inside chemically frosted. Frost densities can range from a #1 1F, similar to "A" line frost, to a pale #7 1F, used in spot reflector lamps. The bulbs can be stained and coated with a colored luster. No transparent ceramic paint is available for low expansion glasses. The bulbs can also be metalized on an inside wet silver process or flashed aluminum.

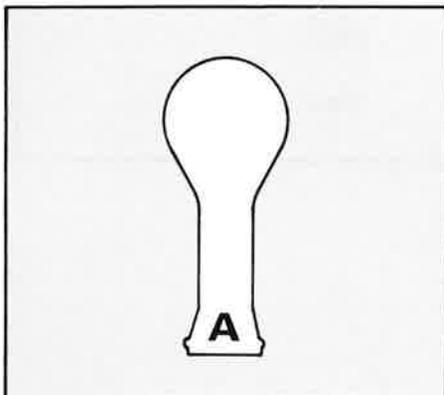
## Packaging

Borosilicate glass bulbs can be packed bulk, tier, cell, or sleeve. Generally, the type of packing used is determined by the cost, size and fragility of the items. Bulk pack is the most dense, and least expensive, but is also least protective and has highest breakage. Cell pack is the least dense, most expensive and most protective. Standard packing options available on bulbs are listed on individual specifications along with count.

# Shape, Size, and Finishing Availability

# SG 772

## Shape



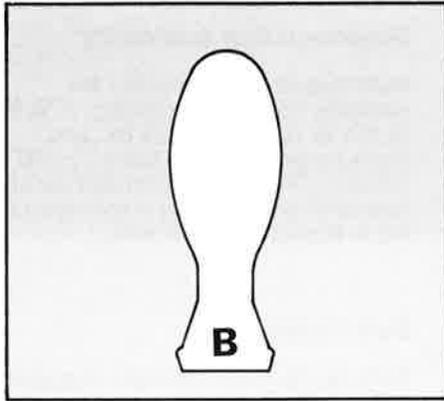
## Availability

Size	Finish
23	Clear

# Shape, Size, and Finishing Availability

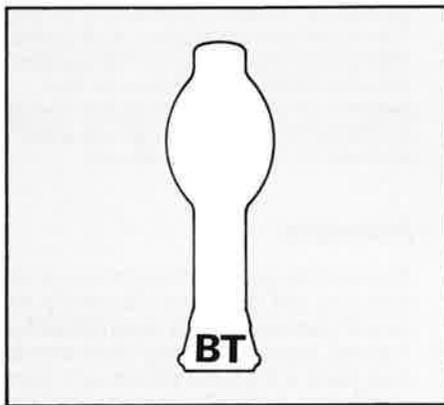
# SG 772

## Shape

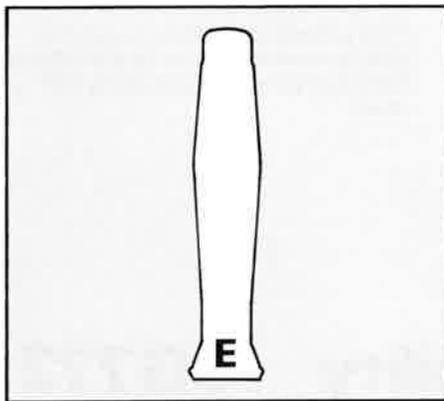


## Availability

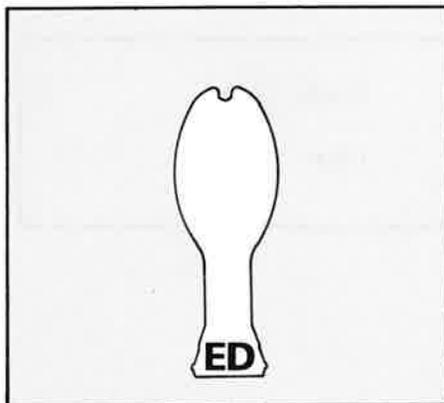
Size	Finish
17, 21	Clear



Size	Finish
25, 28, 37, 46, 56	Clear



Size	Finish
18, 25	Clear



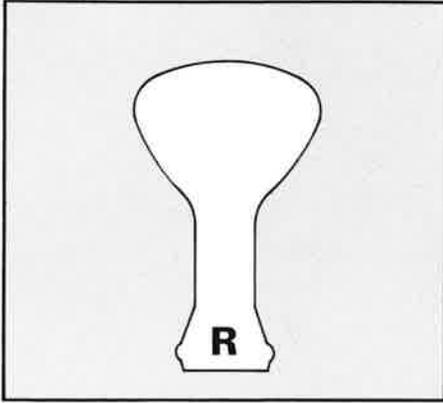
Size	Finish
17, 23½, 28, 37	Clear

# Shape, Size, and Finishing Availability

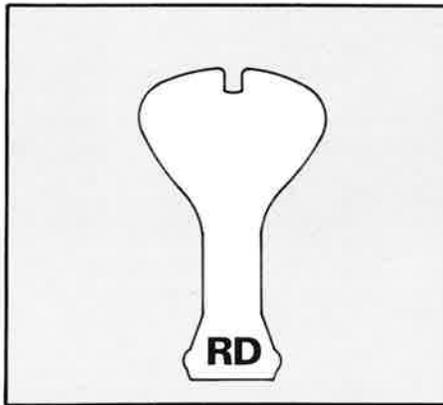
# SG 772

Shape

Availability



Size	Finish*
40, 52, 57, 60, 80	Clear, Frosted, Stained, Neck Silvered



Size	Finish
40, 60	Clear, Frosted, Neck Silvered



# Borosilicate Glass

# SG 776

## Introduction

SG776 is a general use borosilicate glass. This glass is formulated to be compatible to blown ware forming processes and to seal to tungsten sealing glasses, such as 7720 or 3320. This glass is also capable of having controlled UV transmittance. Like other borosilicate glasses, it has excellent weathering and chemical durability, along with good thermal shock resistance.

## Applications

Blown Glassware items made of SG776 are used in the following applications:

Sun lamp envelope where the controlled UV transmittance is utilized.

High wattage incandescent heat and projector lamps where the thermal shock resistance is utilized.

Outdoor incandescent lamps where the thermal shock resistance is utilized.

## Physical Properties

### Mechanical:

Density:	2.24g/cm <sup>3</sup>
Young's Modulus:	6.3 × 10 <sup>3</sup> kg/mm <sup>2</sup> (12.7 × 10 <sup>6</sup> psi)
Poisson's Ratio:	.20
Shear Modulus:	3.4 × 10 <sup>3</sup> kg/mm <sup>2</sup> (5.1 × 10 <sup>6</sup> psi)
Knoop Hardness:	480

### Viscosity:

Working Point	1198°C
Softening Point	780° ± 5°C
Annealing Point	523° ± 5°C
Strain Point	478°C

### Thermal Expansion:

Coef. of Exp. (× 10 <sup>-7</sup> /°C)	34 ± 1.5
Room Temp/S.P. (× 10 <sup>-7</sup> /°C)	37.5

### Optical:

Index of Refraction	1.474
Birefringence Constant	380 (nm/cm) (kg/mm <sup>2</sup> )
Transmittance (sun lamp quality) at 302 mu thru 1mm	44% to 48%

Key properties: softening point, anneal point and expansion are controlled within specified tolerances to insure a compatible sealing glass. The values given for the other properties are typical, however, the deviation from these values would be small since glass composition must be held very precisely to maintain the control of the key properties.

## Typical Chemical Composition

SiO <sub>2</sub>	78%
Al <sub>2</sub> O <sub>3</sub>	2%
B <sub>2</sub> O <sub>3</sub>	15%
Na <sub>2</sub> O	3%
K <sub>2</sub>	1%
As <sub>2</sub> O <sub>3</sub>	1%

## Shape and Size Availability

Bulb shapes of the following are available from existing tooling. G, GT, PS, R, RL. Sizes range from "25" (3.25") to "40" (5"). Other shapes can be manufactured with procurement of tooling up to 10" in diameter and 16" long. Any shape that is made in SG772, can be made in SG776. However, SG776 is not recommended for use in general use mercury discharge lamps because of the U.V. transmittance.

## Bulb Finishing

Bulb can be clear or inside chemically frosted. Frost densities can range from a #1 F, similar to "A" line frost, to a pale #7 IF, used in spot reflector lamps. The bulbs can be stained and coated with a colored luster. No transparent ceramic paint is available for low expansion glasses. The bulbs can also be metalized on the inside through a wet silver process or flashed aluminized.

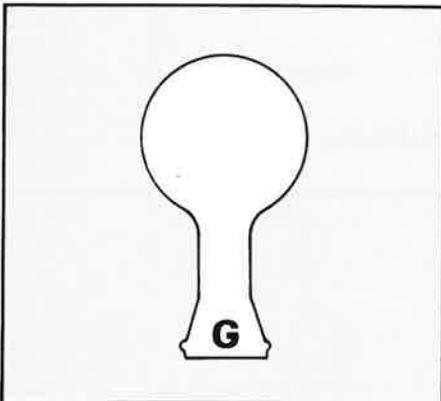
## Packaging

Borosilicate glass bulbs can be packed bulk, tier, cell, or sleeve. Generally, the type of packing used is determined by the product, cost, size and fragility of the items. Bulk pack is the most dense, and least expensive, but is also least protective and has highest breakage. Cell pack is the least dense, most expensive and most protective. Standard packing options available on bulbs are listed on individual specifications along with count.

# Shape, Size, and Finishing Availability

# SG 776

## Shape

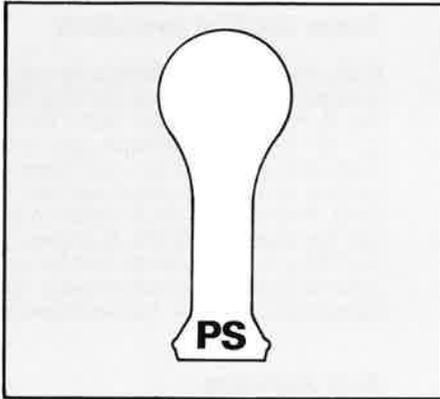


## Availability

Size	Finish
25, 40, 48	Clear, Frosted

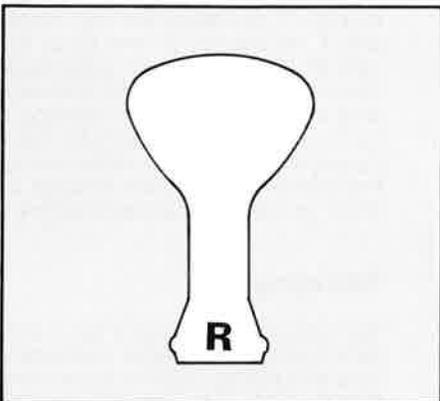
# Shape, Size, and Finishing Availability **SG 776**

## Shape

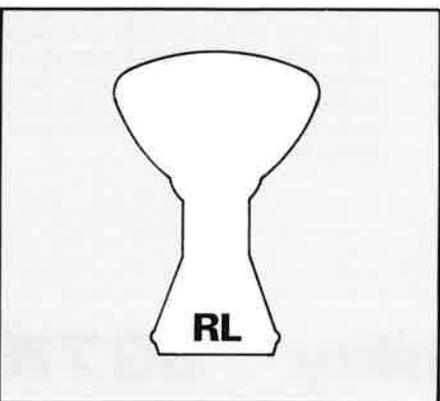


## Availability

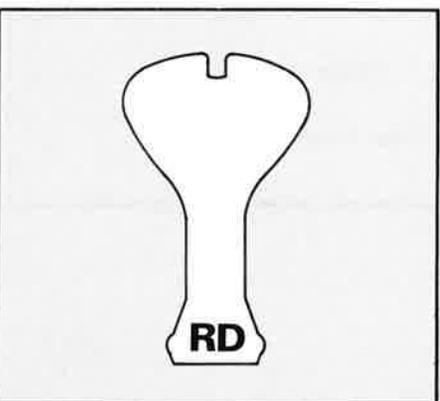
Size	Finish
30, 35, 40, 52	Clear, Frosted



Size	Finish
40, 57	Clear, Frosted, Stained, Neck Silvered



Size	Finish
38	Clear, Neck Silvered

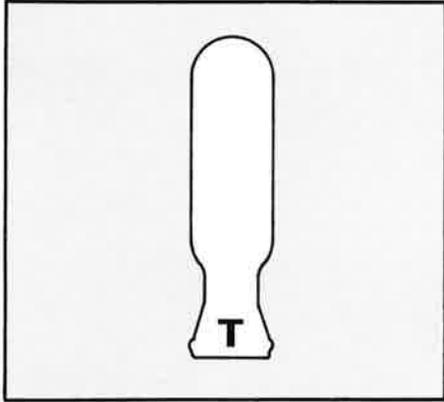


Size	Finish
40, 60	Clear, Frosted, Neck Silvered

# Shape, Size, and Finishing Availability

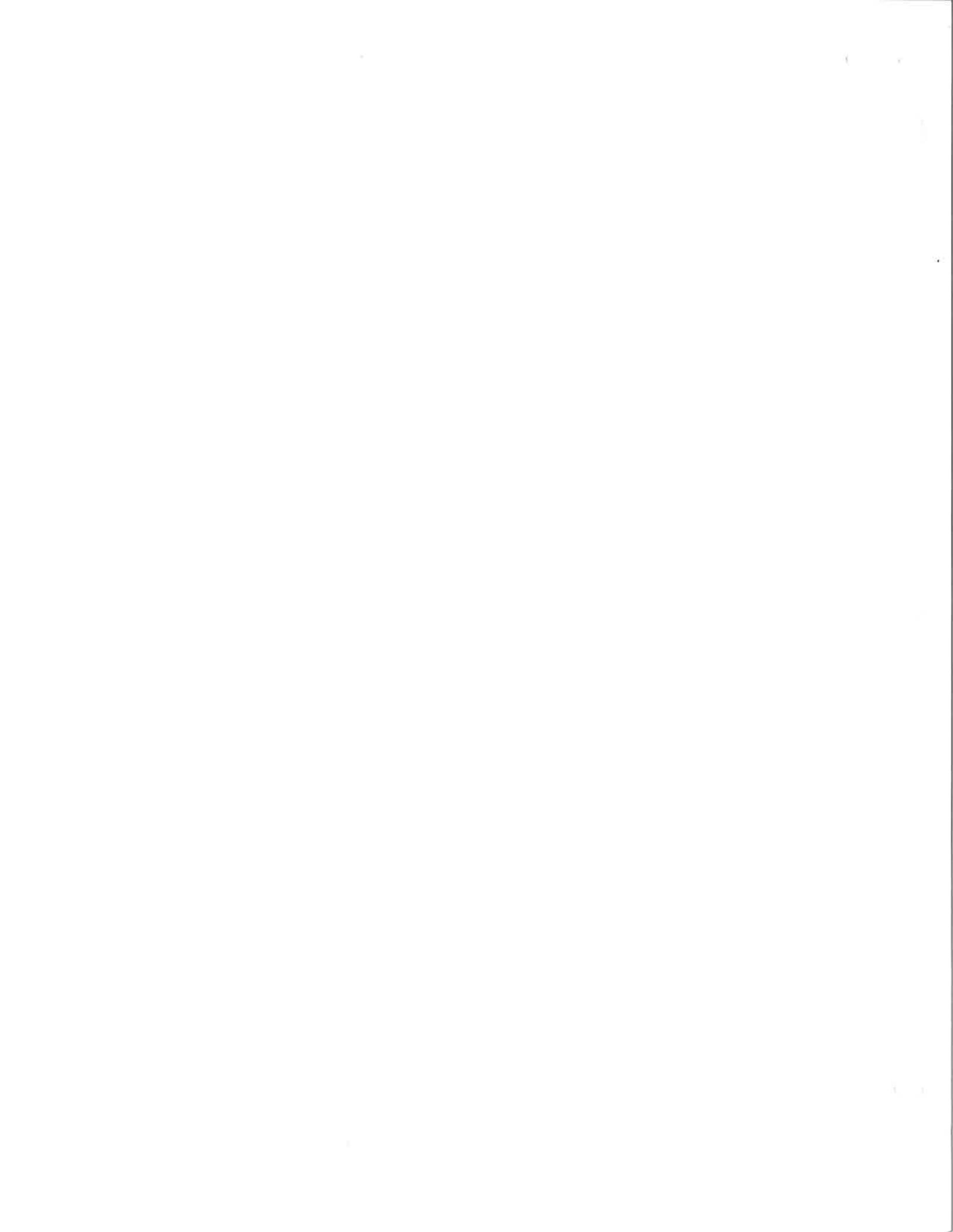
# SG 776

Shape



Availability

Size	Finish
12, 14½, 16, 20, 24	Clear



## Introduction

SG172 is a general use aluminosilicate. This glass was originally formulated for applications requiring high service temperature, such as ignition tubes. It is only recently that it has been used in blown ware forming processes. This glass has several interesting properties which could extend its application in the blown glassware form.

Withstands service temperatures 30 to 40% higher than borosilicates.

Weathering durability equal to the borosilicates.

Extremely tight structured glass, reduces outgassing in higher temperature, longer life lamps.

Fairly good thermal shock resistance.

Better resistivity and dielectric constant than the borosilicates or potash glasses.

## Applications

This glass is currently available in only two bulb types T12GP1 and T20CE1, which are used in high wattage projection lamps. Other shapes have and can be formed in this glass, which could be used in applications requiring the unique properties of SG172.

## Physical Properties

### Mechanical:

Density:	2.52g/cm <sup>3</sup>
Young's Modulus:	8.9 × 10 <sup>3</sup> kg/mm <sup>2</sup> (12.7 × 10 <sup>6</sup> psi)
Poisson's Ratio:	.24
Shear Modulus:	3.6 × 10 <sup>3</sup> kg/mm <sup>2</sup> (5.1 × 10 <sup>6</sup> psi)
Knoop Hardness:	551

### Viscosity:

Working Point	1202°C
Softening Point	915 ± 5°C
Annealing Point	712 ± 5°C
Strain Point	667°C

### Thermal Expansion:

Coef. of Exp. (× 10 <sup>-7</sup> /°C)	42 ± 1.5
Room Temp/S.P. (× 10 <sup>-7</sup> /°C)	52

### Expansion mismatch

with tungsten	350 ppm greater
with moly	290 ppm less
with 7720	150 ppm greater
with 1720	0 ppm

### Optical:

Index of Refraction	1.53
Birefringence Constant	$\frac{260 \text{ (nm/cm)}}{\text{(kg/mm}^2\text{)}}$

### Electrical:

Log <sub>10</sub> Volume Resistivity	
@ 250°C	11.4 Ω cm
@ 350°C	9.5 Ω cm
Loss Tangent @ 20°C	.38%
Dielectric Constant	7.2

Key properties: softening point, anneal point and expansion are controlled within specified tolerances to insure a compatible sealing glass. The values given for the other properties are typical, however, the deviation from these values would be small since glass composition must be held very precisely to maintain the control of the key properties.

## Typical Chemical Composition

SiO <sub>2</sub>	62%
Al <sub>2</sub> O <sub>3</sub>	17%
B <sub>2</sub> O <sub>3</sub>	5%
Na <sub>2</sub> O	1%
MgO	7%
CaO	8%

## Shape and Size Availability

Any shape made in SG772 or SG776 can possibly be formed in SG172. Since very few shapes have actually been formed in SG172, an experiment would be required to verify that a specific shape can be blown in this glass.

## Bulb Finishing

SG172 blown glassware can be metallized on the inside through a wet silver process or flashed aluminized. This glass will not respond to any staining process and no transparent ceramic paints exist of compatible expansion. It is not know how SG172 will respond to inside chemical frost processes.

## Packaging

Aluminosilicate glass bulbs can be packed bulk, tier, cell, or sleeve. Generally, the type of packing used is determined by the cost, size and fragility of the items. Bulk pack is the most dense, and least expensive, but is also least protective and has highest breakage. Cell pack is the least dense, most expensive and most protective. Standard packing options available on bulbs are listed on individual specifications along with count.

