

AAMA MCWM-1-89

Metal Curtain Wall Manual

Section 1 - Guide Specifications

Section 2 - Technical Data





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Publish Date: 1989 Reprint Date: 12/2002

The American Architectural Manufacturers Association (AAMA) is a trade association of firms engaged in the manufacture and sale of architectural building components and related products. Tracing its origins back over 50 years, AAMA is active in its role as the "Technical Information Center" for the industry's products. These include windows, sliding glass doors, storm windows and doors, curtain walls, storefronts, skylight and space enclosures, siding, and related products.

AAMA activities cover a broad scope:

1. Developing specifications for the maintenance of quality standards for the guidance of architects and builders, and to develop public confidence in the quality, performance, and reliability of the industry's products.
2. Encouraging research and development of new or improved products within the industry.
3. Promoting the progress and development of the industry by conducting studies, programs, activities, and projects to increase the use of and markets for the products of the industry.

And, to undertake such other programs as may be proper to enhance or promote the welfare of the industry in the public interest.

This manual was developed by representative members of the American Architectural Manufacturers Association. It is published primarily as a service to architects and secondarily as a service to manufacturers and installers of these products. AAMA disclaims any responsibility or liability of any kind in connection with material contained in the manual and makes no warranties, expressed or implied of any kind whatsoever regarding the information contained herein. Furthermore, none of the contents of the manual shall be construed as a recommendation of any patented or proprietary application that may be included in such contents.

FOREWORD

The original Guide Specifications for Metal Curtain Walls were first published in 1960 by the National Association of Architectural Metal Manufacturers, NAAMM, as a section of its Metal Curtain Wall Manual. A revised edition of this manual was published by NAAMM in 1968.

AAMA, whose membership represents manufacturers, producers and suppliers of architectural products and related services, organized a Curtain Wall Division in 1968. Shortly thereafter those companies in NAAMM interested in curtain walls and storefronts transferred their membership to AAMA and the Curtain Wall Division was expanded to represent companies interested in

architectural windows, storefronts and entrances as well as curtain walls. The division then became known as the Architectural Window, Curtain Wall and Storefront Division of AAMA. As part of its continuing program for the preparation and publication of current information on the advancing technology of curtain wall and storefront design, AAMA, in 1973, acquired the publication rights to NAAMM's Metal Curtain Wall Manual, Entrance Manual and other related technical literature and standards with a commitment to revise and republish them as AAMA documents. In line with this commitment AAMA published its Metal Curtain Wall, Window, Storefront and Entrance Guide Specifications Manual in 1976 and its Aluminum Storefront and Entrance Design Guide Manual in 1977.

The Metal Curtain Wall Guide Specifications in this publication replace those which appeared in the 1976 publication. The Storefront and Entrance Guide Specifications were revised and published separately in 1987. The Voluntary Guide specifications of Aluminum Architectural Windows were published separately in 1984. This has been done so that specifications can be more expeditiously and economically revised when changes and advances in technology dictate such action.

As before, the primary objective of these guide specifications is to provide the Architect with current, useful, reliable and unbiased technical information as an aid in designing and specifying good construction for metal curtain walls. The secondary objective is to provide competent guidance for the manufacturers and installers of curtain walls. The overall aim is to promote better design and application by encouraging a mutual understanding of the common interests of architects, manufacturers and suppliers. In addition to these Guide Specifications, AAMA has an Aluminum Curtain Wall series of publications on design, materials, finishes, fabrication, installation, testing and other aspects of curtain wall construction.

DRAWINGS AND SPECIFICATIONS

Introduction

Drawings and specifications are the two basic documents which the architect develops to convey the information needed for the construction of any structure. They are complementary documents and information contained in one should not be duplicated in the other. However, a consistent system must be used to reference one to the other and standard terminology must be employed in both if the contractor is to have a clear and complete understanding of the documents.

Metal curtain wall systems connect to many other parts of the buildings. As a consequence the work of numerous trades, both directly and indirectly concerned, is involved in their installation. Thus, for a wall contractor to properly

bid a job, he must be able to precisely determine the extent of his responsibility from the information shown on the drawings and set forth in the specifications.

Metal curtain wall systems are used to enclose buildings ranging from one story up to one hundred plus stories. In high rise buildings the ground floor level wall will generally be different from that of the rest of the building. It will incorporate storefronts and entrances. The wall contractor may install this portion of the wall but often it is done by another contractor. It is important, therefore, that a proper delineation be made between the storefront areas and the other areas of the wall.

Drawings

Drawings must show the complete curtain wall system, the grid framework, panels, fixed glass, operating windows, doors, and other components of the system. They must be accurately dimensioned with section drawings sufficient to clearly define the product requirements. Connections between the wall and the building structure, storefront, roof, floors, ceilings, partitions, etc., must be shown with a precise indication of where the work of the curtain wall contractor starts and stops. This should be correlated with the written description in the specifications. Drapery tracks, flashing reglets, flashings, and other items which are not part of the wall must be noted on the drawings as well as in the specifications. Proprietary items should be appropriately identified. Sealants shown on the drawings should be referenced to the specifications and those sealants which are a responsibility of the wall contractor should be pointed out. Tolerances and clearances shown on drawings must accommodate the tolerances specified for the structural frame of the building. A complete and accurate set of drawings is essential to efficient, economical execution of a project. Shop drawings prepared by a fabricator or erector require the Architect's approval prior to initiation of work.

It is important that schedules be shown on the drawings. This facilitates execution of the work and helps eliminate errors and omissions. These schedules will include metals, finishes, panels, glass, windows, doors, proprietary components, insulation, sealing, glazing, and flashings. References to appropriate paragraphs in the specifications should be shown on the schedule.

Specifications

The guide specifications set forth in this manual cover the complete exterior metal curtain wall. They follow the three-part section format for construction specifications, Part 1 General, Part 2 Products, and Part 3 Execution, recommended by the Construction Specifications Institute, CSI.

General

As noted in the requirements for drawings, the metal curtain wall system must physically connect with the building structure, storefront, roof, floors, ceilings, partitions, and other items. The specifications, therefore, must define very precisely that part of the work which is to be performed under the curtain wall section and that part of the related work which is to be performed under other sections. This division of work should be cross-referenced and clearly indicated on the drawings.

Descriptions of product, references, qualifications, performance requirements, testing, mock-ups, submittals, and warranties should be specified in this part.

Product

The product specifications must describe the metals, finishes, protective coatings, proprietary wall systems or components, framing systems, windows, doors, panels, glass, insulation, sealants, glazing materials and other items required to fabricate a wall.

Fabrication requirements should also be specified in this part. They include special fabricating procedures, shop assembly, mechanical fastening, welding, protection of metals, painting, and sealing of joints.

Execution

This part of the specifications must cover the requirements for referencing the wall to the building structure, erection tolerances, clearances, installation, welding, sealing, glazing, insulating, protecting, cleaning, and other work to be accomplished on the building site.

CSI Masterformat

CSI Masterformat lists curtain walls under Division 8-Doors and Windows. Glazed curtain walls in general come under Broadscope Section 08900. The principal metals which have been used in curtain wall construction are aluminum, steel, stainless steel and bronze. All four metals are covered in these specifications. The CSI Mediumscope Sections for different types of curtain walls, including those incorporating these four metals, are listed below.

Section #	Title
08900	GLAZED CURTAIN WALLS
-910	Glazed Steel Curtain Walls
-920	Glazed Aluminum Curtain Walls
-930	Glazed Stainless Steel Curtain Walls
-940	Glazed Bronze Curtain Walls
-950	Translucent Wall and Skylight Systems
-960	Sloped Glazing Systems
-970	Structural Glass Curtain Walls

Broadscope Explanation

08900-GLAZED CURTAIN WALLS

Standard and custom fabrications of framing members, sash, glazing, spandrel panels, fasteners, and sealants normally installed as an integrated system forming the exterior glazed vertical closure or vertical and sloped closure of a structure.

Related Work:

Skylights: Section 07800.

Glazing: Section 08800.

NOTE: *Glazing is specified under section 08800 unless system is pre-glazed.*

NOTES ON GUIDE SPECIFICATIONS

The guide specifications are a compendium of paragraphs covering a number of performance and testing requirements, a variety of materials and products, plus fabrication and installation methods for the different items commonly used in metal curtain wall construction. In writing the specifications for any one project the Architect will therefore delete many of the paragraphs as being inapplicable using only those which are pertinent. In some cases, of course, he may add paragraphs to meet special requirements of his design.

Voluntary industry standards, current at the time of publishing this manual, are referred to throughout the specifications. However, since some of these standards

are being revised and new ones are being developed, the Architect may find it necessary to refer to up-dated and new standards in preparing his specifications. Latest information can be obtained by contacting the organizations which develop and publish standards. A list of the standards and the organizations which publish them appears in paragraph 1.06, References, of these specifications.

The term "approved drawings" appears throughout the specifications. Where it appears it shall be interpreted to mean the final approval of the party responsible for the specific item, Architect, General Contractor or other party.

Type and symbols used have the following significance:

Blanks . . . (A) . . . : To be filled in appropriately by the Architect.

[Brackets]: Require decision on the part of the Architect relative to selection and inclusion in the specifications.

[] [or] []: Architect must select

(Parentheses): Enclose specific instructions.

Italics: Explanatory notes, instructions and commentary text presenting supplementary information and data. Not to be included as part of the specifications.

SECTION 1

GUIDE SPECIFICATIONS

CSI BROADSCOPE SECTION 08900

PART 1 — GENERAL

1.01 DESCRIPTION OF PRODUCT

A. The metal curtain wall system specified in this section is to enclose a . . . (A) . . . story [monumental] [commercial] [institutional] [industrial] [residential] [office] [apartment] [other] building.

B. The system includes the curtain wall framing, anchors, glass, glazing, panels, insulation, sealants, windows, doors and other components required for the complete system and its installation.

C. The metal curtain wall is defined for this section as that part of the exterior building enclosure . . . (*Give specific definition per commentary*) . . .

A clear definition of what constitutes the curtain wall is important to the estimator in attempting to prepare an accurate bid. To more accurately define the requirements of this section the architect should state here where the wall begins and where it ends. For example, from the base of the wall at the second floor level (EI.) to the top of the wall at (EI.) but not including the soffit material at (EI.) or the coping at (EI.). This information should also be clearly indicated on the drawings. If the curtain wall is a composite of metal and masonry it should be so stated here. This section should include only the metal curtain wall specifications with the data on the masonry wall specifications included in Section 04xxx.

1.02 WORK INCLUDED

A. Metal Framing for Glass, Panels and Other Components

B. Glass

If not included in this section include in Section 08800

C. Panels

D. Anchors, Brackets and Attachments

E. Windows

If not included in this section include in Section 08500

F. Doors

If not included in this section include in Section 08250

G. Column Covers

H. Insulation

I. Fire Stops at Floor Slabs

J. Perimeter Sealant

If not included in this section include in Section 07900

K. Final Cleaning

If not included in this section include in Section 01710

1.03 ITEMS INSTALLED BUT FURNISHED UNDER OTHER SECTIONS

A. Windows (*When not supplied by curtain wall manufacturer*)..... Section 08500

B. Doors (*When not supplied by curtain wall manufacturer*)..... Section 08250

C. Other items..... Section xxxxx

1.04 ITEMS FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

A. Inserts and Anchors which are Cast in Concrete
..... Section 03250

B. Inserts and Anchors which are Built in Masonry
..... Section 04150

C. Other Items..... Section xxxxx

1.05 RELATED WORK SPECIFIED

ELSEWHERE (*Illustrative examples only*)

A. Staging and Scaffolding Section 01525

B. Final Cleaning (*If not in this section*) Section 01710

C. Preparation of Adjacent Work Section xxxxx

D. Structural Steel Including Inserts and Anchors
..... Section 05120

E. Metal Fabrications, Framing and Attachments
..... Section 05500

F. Sheet Metal Flashing and Trim Section 07620

G. Skylights Section 07800

H. Perimeter Sealing (*If not in this section*) Section 07900

I. Metal Closures and Trim Section 08xxx

J. Store Fronts and Entrances..... Section 08400

K. Window Stools Section 08500

L. Glass and Glazing for Curtain Wall
(*If not in this section*)..... Section 08800

M. Glass and Glazing Other than Curtain Wall
..... Section 08800

N. Sloped Glazing Section 08960

O. Interior Wall Finish..... Section 09xxx

P. Exterior Sun Control Devices Section 10700

Q. Window Washing Equipment..... Section 11014

R. Mechanical Units and Grilles Attached to the Curtain Wall Section 15xxx

1.06 REFERENCES

All standards and other literature referred to in these guide specifications and their accompanying commentary are listed in this paragraph. The dates shown were current at the time of publication of this document. Names and addresses of the organizations involved are given to facilitate contact.

A. Aluminum Association (AA)

900 19th Street, NW
Washington, DC 20006

1. Aluminum Standards and Data, 1982, ASD-1
2. Designation System for Aluminum Finishes, 1980, DAF-45
3. Standards for Anodized Architectural Aluminum, 1978, SAA-46

B. American Architectural Manufacturers Association (AAMA)

1827 Walden Office Square, Suite 550
Schaumburg, IL 60173

1. SI-2-88 Specification for Preformed Fibrous Glass Insulation
2. 501-83 Methods of Test for Metal Curtain Walls
3. 501.1-83 Standard Test Method for Metal Curtain Walls for Water Penetration Using Dynamic Pressure
4. 501.2-83 Field Check for Metal Curtain Walls for Water Leakage
5. 603.8-85 Performance Requirements and Test Procedures for Pigmented Organic Coatings on Extruded Aluminum
6. 605.2-85 Voluntary Specification for High Performance Organic Coatings on Architectural Extrusions and Panels.
7. 800-86 Voluntary Specifications and Test Methods for Sealants containing the following specifications and test methods:
 - a. 803.3-85 Voluntary Specification for Narrow-Joint Seam Sealer
 - b. 804.1-85 Voluntary Specification for Ductile Back-Bedding Glazing Tapes
 - c. 805.2-85 Voluntary Specification for Bonding-Type Back-Bedding Compound
 - d. 806.1-85 Voluntary Specification for Bonding-Type Back-Bedding Glazing Tapes
 - e. 807.1-85 Voluntary Specification for Oil-Extended Cured Rubber Back-Bedding Glazing Tapes
 - f. 808.3-85 Voluntary Specification for Exterior Perimeter Sealing Compound
 - g. 809.2-85 Voluntary Specification for Non-Drying Sealants
 - h. 810.1-85 Voluntary Specification for Expanded Cellular Glazing Tape

8. 1402-85 Standard Specifications for Aluminum Siding, Soffit and Fascia
9. 1502.7-81 Voluntary Test Method for Condensation Resistance of Windows, Doors and Glazed Wall Sections
10. 1503.1-80 Voluntary Test Method for Thermal Transmittance of Windows, Doors and Glazed Wall Sections
11. ANSI/AAMA 101-88 Voluntary Specifications for Aluminum Prime Windows & Sliding Glass Doors
12. GS 001-84 Voluntary Guide Specifications for Aluminum Architectural Windows
13. Aluminum Curtain Wall Design Guide Manual, 1979 (Aluminum Curtain Wall Series, ACWS, Volumes 1 through 9)
 - a. Testing of Aluminum Curtain Walls
 - b. Aluminum Curtain Wall Types and Systems
 - c. The Rain Screen Principle and Pressure-Equalized Wall Design
 - d. Primary Concerns in Aluminum Curtain Wall Design
 - e. Guidelines for the Architect in Detailing the Wall
 - f. Lockstrip Gaskets in Architectural Applications
 - g. A Brief History of the Aluminum Curtain Wall
 - h. Fire Safety in High Rise Curtain Wall Buildings
 - i. Joint Sealants in Aluminum Curtain Walls
 - j. Glass and Glazing
 - k. Installation of the Aluminum Curtain Wall
 - l. Anodic Finishes
 - m. Design for Energy Conservation in Aluminum Curtain Walls
14. ACWS Vol. 10 Care and Handling of Architectural Aluminum from Shop to Site
15. ACWS Vol. 11 Design Wind Loads for Buildings and Boundary Layer Wind Tunnel Testing
16. ACWS Vol. 12 Structural Properties of Glass
17. ACWS Vol. 13 Structural Sealant Glazing Systems
18. TIR-A1-75 Sound Control for Aluminum Curtain Walls and Windows
19. TIR-A3-75 Fire Resistive Design Guidelines for Curtain Wall Assemblies
20. TIR-A4-78 Recommended Glazing Guidelines for Reflective Insulating Glass

C. American Institute of Steel Construction (AISC)

400 North Michigan Avenue
Chicago, Illinois 60611-4185

1. Manual of Steel Construction

D. American Iron and Steel Institute (AISI)

1133 Fifteenth Street, NW
Washington, DC 20005

1. Steel Products Manual
 - a. Carbon Steels
 - b. Stainless and Heat Resisting Steels

E. American National Standards Institute (ANSI)

25 West 43rd Street, 4th Floor
New York, NY 10036

1. A58.1-82 Minimum Design Loads for Buildings and Other Structures
2. ANSI/AAMA 101-88 Voluntary Specifications for Aluminum Prime Windows & Sliding Glass Doors
3. ANSI/ASME A39.1-87 Safety Requirements for Window Cleaning
4. S1.4-83 Specification for Sound Level Meters
5. S1.4a-85 Sound Level Meters
6. Z97.1-84 Performance Specifications and Methods of Test for Safety Glazing Material Used in Buildings

F. American Society for Testing and Materials (ASTM)

100 Barr Harbor Drive
West Conshohocken, PA 19428

1. A 36-87 Specification for Structural Steel
2. A 123-84 Specification for Zinc (Hot Dipped-Galvanized) Coatings on Iron and Steel Products
3. A 176-87 Specification for Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip
4. A 268-87a Specification for Seamless and Welded Ferritic Stainless Steel Tubing for General Service
5. A 269-87 Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
6. A 424-80 Specification for Steel Sheets for Porcelain Enameling
7. A 446-87 Specification for Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Structural (Physical) Quality
8. A 526-85 Specification for Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Commercial Quality
9. A 570-85 Specification for Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality
10. A 572-84 Specification for High-Strength Low-Alloy Columbium-Vanadium Steels of Structural Quality
11. A 591-77 (1983) Specification for Sheet Steel, Cold-Rolled, Electrolytic Zinc-Coated
12. A 607-85 Specification for Steel Sheet and Strip, Hot-Rolled and Cold-Rolled, High-Strength, Low-Alloy Columbium and/or Vanadium
13. A 611-85 Specification for Steel, Cold-Rolled Sheet, Carbon, Structural
14. A 618-84 Specification for Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing
15. A 633-87 Specification for Normalized High-Strength Low-Alloy Structural Steel
16. A 666-87 Specification for Austenitic Stainless Steel, Sheet, Strip, Plate, and Flat Bar for Structural
17. B 26-88 Specification for Aluminum-Alloy Sand Castings
18. B 43-88 Specification for Seamless Red Brass Pipe, Standard Sizes
19. B 85-84 Specification for Aluminum-Alloy Die Castings

20. B 108-87 Specification for Aluminum-Alloy Permanent Mold Castings
21. B 209-88 Specification for Aluminum and Aluminum-Alloy Sheet and Plate
22. B 210-88 Specification for Aluminum-Alloy Drawn Seamless Tubes
23. B 211-88 Specification for Aluminum-Alloy Bars, Rods, and Wire
24. B 221-88 Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes
25. B 308-88 Specification for Aluminum-Alloy 6061-T6 Standard Structural Shapes, Rolled or Extruded
26. B 429-88 Specification for Aluminum-Alloy Extruded Structural Pipe and Tube
27. B 455-83 Specification for Copper-Zinc-Lead Alloy (Leaded Brass) Extruded Shapes
28. B 633-85 Specification for Electrodeposited Coatings of Zinc on Iron and Steel
29. B 766-86 Specification for Electrodeposited Coatings of Cadmium
30. C 236-87 Test Method for Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box
31. C 509-84 Specification for Cellular Elastomeric Preformed Gasket and Sealing Material
32. C 542-82 (1984) Specification for Lock-Strip Gaskets
33. C 552-86 Specification for Cellular Glass Block and Pipe Thermal Insulation
34. C 553-70 (1977) Specification for Mineral Fiber Blanket and Felt Insulation
35. C 864-84 Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers
36. C 976-82 Test Method Thermal Performance of Building Assemblies by Means of a Calibrated Hot Box
37. C 991-83 Specification for Flexible Glass Fiber Insulation for Pre-Engineered Metal Buildings
38. C 1036-85 Standard Specification for Flat Glass
39. C 1048-87 Standard Specification for Heat-Treated Flat Glass — Kind HS, Kind FT Coated and Uncoated Glass
40. D 3656-83 Specification for Insect Screening and Louver Cloth Woven from Vinyl Coated Glass Fiber Yarn
41. E 84-87 Test Method for Surface Burning Characteristics of Building Materials
42. E 90-87 Standard Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions
43. E 119-88 Method for Fire Tests of Building Construction and Materials
44. E 136-82 Test Method for Behavior of Materials in a Vertical Tube Furnace at 750C
45. E 283-84 Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors
46. E 330-84 Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference
47. E 331-86 Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference

- 48. E 413-87 Standard Classification for Determination of Sound Transmission Class
- 49. E 546-88 Test Method for Frost Point of Sealed Insulating Glass Units
- 50. E 576-88 Test Method for Dew/Frost Point of Sealed Insulating Glass Units in Vertical Position
- 51. E 773-88 Test Method for Seal Durability of Sealed Insulating Glass Units
- 52. E 774-84a Specification for Sealed Insulating Glass Units
- 53. E 783-84 Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors
- 54. E 1105-86 Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Curtain Walls, and Doors by Uniform or Cyclic Air Pressure Difference

G. American Welding Society

550 N.W. LeJeune Road
 PO Box 351040
 Miami, FL 33135

- 1. A5.10-80 Specification for Aluminum and Aluminum Alloy Bare Welding Rods and Electrodes
- 2. D1.1-86 Structural Welding Code — Steel
- 3. D1.2-83 Structural Welding Code — Aluminum

H. Canadian Government Specifications (CGSB)

Canadian Government Specifications Board
 88 Metcalfe Street
 Ottawa, Canada K1A 0S5

- 1. 19-GP-1c Glass, Safety, Tempered or Laminated, for Building Construction
- 2. 19-GP-5b Sealing Compound, One Component, Acrylic Base, Solvent Curing
- 3. 19-GP-9b Sealing Compound, One Component, Silicone Base, Chemical Curing
- 4. 19-GP-14 Sealing Compound, One Component, Butyl-Polisisobutylene Base, Solvent Curing
- 5. 19-GP-15a Sealing Compound, Multicomponent, Polyurethane Base, Chemical Curing
- 6. 19-GP-16a Sealing Compound, One Component, Polyurethane Base, Chemical Curing
- 7. 19-GP-18 Sealing Compound, One Component, Silicone Base, Solvent Curing

I. Consumer Products Safety Commission (CPSC)

Washington, DC 20207

- 1. 16 CFR 1201 Safety Standard for Architectural Glazing Materials

J. Copper Development Association (CDA)

Greenwich Office Park 2
 PO Box 1840
 Greenwich, CT 06836

- 1. Standard Handbook, Copper, Brass and Bronze

K. Flat Glass Marketing Association (FGMA)

3310 Harrison
 Topeka, KS 66611

- 1. Glazing Manual
- 2. Sealant Manual

L. General Services Administration (GSA),

**Federal Specifications (FS)
 Specifications Unit (WFSIS)**

7th and D Streets, SW
 Washington, DC 20406

- 1. HH-I-521F Insulation Blankets, Thermal (Mineral Fiber, for Ambient Temperatures)
- 2. HH-I-524C Insulation Board, Thermal (Polystyrene)
- 3. HH-I-526C Insulation Board, Thermal (Mineral Fiber)
- 4. HH-I-530B Insulation Board, Thermal, Unfaced, Polyurethane or Polyisocyanurate
- 5. HH-I-551E Insulation Blocks and Boards, Thermal (Cellular Glass)
- 6. HH-I-558B(3) Insulation, Blocks, Boards, Blankets, Sleeving (Pipe and Tube Covering), and Pipe Fitting Covering, Thermal (Mineral Fiber, Industrial Type)
- 7. RR-W-365A Wire Fabric (Insect Screening)
- 8. SS-C-153C Cement, Bituminous, Plastic
- 9. TT-P-38D(1) Paint, Aluminum, Ready-Mixed
- 10. TT-P-645A Primer, Paint, Zinc Chromate. Alkyd Type
- 11. TT-S-001543A Sealing Compound: Silicone Rubber Base (for Caulking, Sealing, and Glazing in Buildings and Other Structures)
- 12. TT-S-001657 Sealing Compound: Single-Component, Butyl Rubber Based, Solvent Release Type (for Buildings and Other Types of Construction)
- 13. TT-S-00227E(3) Sealing Compound: Elastomeric Type, Multi-Component (for Caulking, Sealing and Glazing in Buildings and Other Structures)
- 14. TT-S-00230C(2) Sealing Compound: Elastomeric Type, Single Component (for Caulking, Sealing and Glazing in Buildings and Other Structures)

M. Insulating Glass Certification Council (IGCC)

ETL Testing Laboratories, Inc.
 Industrial Park
 3933 U.S. Route 11
 P.O. Box 2040
 Cortland, NY 13045-2040

- 1. Certified Products Directory for Sealed Insulating Glass

N. National Association of Architectural Metal Manufacturers (NAAMM)

600 South Federal Street, Suite 400
 Chicago, IL 60605

- 1. Metal Finishes Manual in Six Sections
 - a. AMP 500-88 Introduction to Metal Finishing

- b. AMP 501-88 Finishes for Aluminum
- c. AMP 502-88 Finishes for the Copper Alloys
- d. AMP 503-88 Finishes for Stainless Steel
- e. AMP 504-88 Finishes for Carbon and Iron
- f. AMP 505-88 Applied Coatings

O. Porcelain Enamel Institute (PEI)

1911 Fort Myer Drive
Arlington, Virginia 22209

- 1. S-100 Specification for Architectural Porcelain Enamel on Steel for Exterior Use

P. Safety Glazing Certification Council (SGCC)

ETL Testing Laboratories, Inc.
Industrial Park
3933 U.S. Route 11
P.O. Box 2040
Cortland, NY 13045-2040

- 1. Certified Products Directory for Safety Glazing Materials Used in Buildings

Q. Sealed Insulating Glass Manufacturers Association (SIGMA)

111 East Wacker Drive, Suite 600
Chicago, Illinois 60601

- 1. Technical Manual for Acoustical Glass

R. Steel Structures Painting Council (SSPC)

4400 Fifth Avenue
Pittsburgh, PA 15213

- 1. Steel Structures Painting Manual in Two Volumes
 - a. Volume 1, Good Painting Practice
 - b. Volume 2, Systems and Specifications
- 2. SSPC-PS 1.04 and 1.07 through 1.13 Oil Base Painting Systems
- 3. SSPC-PS 4.01 through 4.05 Vinyl Painting Systems
- 4. SSPC-PS 11.01 Coal Tar Epoxy-Polyamide Painting System
- 5. SSPC-PS 12.01 One-Coat Zinc Rich Painting System
- 6. SSPC-PS 13.01 Epoxy-Polyamide Painting System
- 7. SSPC-PS 15.00 Chlorinated Rubber Painting System

S. Steel Window Institute (SWI)

2130 Keith Building
Cleveland, Ohio 44115

- 1. Recommended Specifications for Steel Windows

1.07 PERFORMANCE AND TESTING REQUIREMENTS

This is one of the most important parts of curtain wall specifications. The ultimate performance of the building may well depend on how accurately and completely these

specifications are written. Performance requirements dictate the engineering work that goes into a wall design. Structural capabilities of a wall can generally be calculated with adequate accuracy. However, testing is the only way in which certain capabilities of a wall, such as resistance to air leakage or water penetration, can be determined. Testing involves extra costs and tests should, therefore, be specified only when it is necessary to check performance and the time and expense are justified. Many commercial type walls have been rigorously tested during their development and, furthermore, have a history of satisfactory performance. Often their manufacturers can certify compliance with required performance standards, making further testing unnecessary, provided that the intended installation conforms with their recommendations. For unproven wall designs, on the other hand, tests may be not only warranted but highly advisable, as the only means of verifying performance. Before deciding which, if any, tests should be specified, the Architect is advised to consult AAMA Aluminum Curtain Wall Series Volume 1, "Testing of Aluminum Curtain Walls."

When tests are specified, the required performance under those tests should be clearly defined and provision should be made for having corrective work done and re-tested if first results are unsatisfactory.

It is suggested that the Architect add a statement at this point of the specifications to the effect that:

Conformance with the requirements of 1.07 shall be demonstrated, where applicable, by [submitting appropriate manufacturer's standard test reports, calculations, and/or conformance letters] [or] [erecting and testing a job size mock-up . . . (state configuration) . . . and providing test reports by a qualified laboratory (reference 1.08)].

A. Provision for Thermal Movements

Curtain wall systems shall be designed to provide for such expansion and contraction of component materials as will be caused by surface temperatures ranging from . . . (A) . . . C to a high temperature of . . . (A) . . . C [. . . (A) . . . F to a high temperature of . . . (A) . . . F] without causing buckling, undue stress on glass, failure of joint seals, undue stress on structural elements, damaging loads on fasteners, reduction of performance or other detrimental effects. (If applicable add) Operating windows and doors shall function normally over this temperature range.

A representative maximum range of ambient temperature, as here specified, in the vicinity of 40 N. Latitude is about 50°C (120°F). Metal surface temperatures on buildings, however, vary over a much wider range. Dark colored metal may reach temperatures as high as 70°C (160°F) when exposed to direct solar heat, and may be 6°C (10°F) colder than air temperature on clear, still winter nights. The range of temperature of the metal itself is, therefore,

considerably greater than that of the surrounding air and, except in the southern-most states, should be assumed to be at least 82°C (180°F). It is this range, rather than the ambient range, which determines the amount of movement to be expected. Since the latter will vary with the location of the building, it should be determined and specified by the Architect. It is particularly important that the size of the sealant joint take into account the maximum expansion and contraction resulting from this range of surface temperatures as well as the other building movements which will affect the joint. Consideration must also be given to the temperature at the time of installation. If these things are not done correctly, failure in the water and air tightness of the wall may ultimately occur. Glass breakage problems may occur if sufficient clearance is not provided for thermal movements. For further information on this subject reference should be made to AAMA Aluminum Curtain Wall Series No. 7, "Installation of the Aluminum Curtain Wall".

B. Structural Properties

1. Wind Loads

Curtain wall systems shall be designed to withstand the following wind loads acting normal to the plane of the wall.

For exterior walls

On the ground level:

... (A) ... Pa (psf) acting inward

... (A) ... Pa (psf) acting outward

On the ... (A) ... stories:

... (A) ... Pa (psf) acting inward

... (A) ... Pa (psf) acting outward

On the ... (A) ... stories:

... (A) ... Pa (psf) acting inward

... (A) ... Pa (psf) acting outward

On the corner areas extending ... (A) ... mm (ft) from the building corners on the ... (A) ... stories on all facades:

... (A) ... Pa (psf) acting inward

... (A) ... Pa (psf) acting outward

(Note: The inward and outward acting loads are not additive)

Provision is made here for specifying different design wind loads at different building heights and at areas adjacent to the building corners. Wind loads normally increase with the height of the building. In the case of tall buildings desirable economies in structural and material requirements may be realized by specifying different design wind loads at different building heights. Highest wind loads most often occur in the areas adjacent to the building corners. Outward acting wind loads at the corners are generally critical as they are likely to be much more severe than the inward acting loads on corners and other parts of the building.

Unless otherwise required by governing building codes, appropriate design wind loads for most situations may be selected by the Architect from ANSI A58.1, "Minimum Design Loads for Buildings and Other Structures." For other situations where, for example,

- building shape is other than rectangular in plan
- site location has unusual wind conditions
- building location critical with respect to other nearby buildings
- high internal pressure from stack action caused by cold climate

Boundary layer wind tunnel testing and/or special engineering studies maybe essential to determine the required design wind load. For information on design wind loads and wind tunnel testing the Architect is referred to AAMA Aluminum Curtain Wall Series No. 11, "Design Wind Loads for Buildings and Boundary Layer Wind Tunnel Testing."

2. Deflection Limitations and Testing Requirements

a. The deflection of any framing member in a direction normal to the plane of the wall when subjected to design loads specified in 1.07.B.1, shall not exceed 1/175 of its clear span except that when a plastered surface or dry wall subjected to bending is affected, the deflection shall not exceed 1/360 of the span. (Architect specify other deflection limits if required. If actual structural tests are required in lieu of calculations the Architect must include 1.07.B.2.b in the specifications).

b. Uniform load deflection tests of the curtain wall system shall be conducted in accordance with ASTM E 330. Loads and deflection limitations shall be as specified in 1.07.B.2.a.

In cases of large spans the Architect should calculate the mid-point span deflection and give consideration to its visual impact on occupants of the building. If it appears desirable the Architect should specify a lesser deflection than that given by 1/175 of the clear span. Lower deflections, however, will often require the use of heavier cross-sections or reinforcements so the importance of visual impact must be weighed against added cost. Deflections up to 1/60 of the span are permitted for thin metal panels which do not frame glass provided retention is satisfactory and no seal failure will result. Structural sealants may require a lower deflection ratio than 1/175. Sealant manufacturers should be consulted on this matter.

c. The deflection of a framing member overhanging an anchor point (roof, parapets, other components) shall be limited to $[2L/175]$ where L is the length of the cantilevered member [. . . A . . .].

d. The deflection of a framing member overhanging an anchor point and adjoining a fixed building element (*see commentary*) shall be limited to [no more than one-half the sealant joint depth between the framing member and the fixed building element] [. . . A . . .].

It is essential that sealed joints be designed to accommodate the deflection which may occur at the joint. To ensure satisfactory performance of such joints the deflection must be held within limits. In most installations the deflection allowed by 2L/175 will cause no problems. However, depending on the design, there may be surrounding conditions in which the deflection allowed by this ratio will be excessive and can cause serious problems at a sealed joint. To protect against this it is necessary for the Architect to set a lower limit in order to provide good sealing conditions, for example, at the end of an overhanging framing member. Often the roof flashing, parapet cover, soffit material or other building component must be sealed to the member and the sealant joint will not tolerate a liberal deflection at this point.

e. Deflection measurements shall be made from gages located on the [framing members] [and] [metal panels] so as to measure maximum deflections.

f. The methods used to calculate deflections shall be those recommended by AA, AISI, AISC or CDA, whichever is applicable for the metal alloys specified.

3. Dead Load

The deflection of any member in a direction parallel to the plane of the wall, when carrying its full dead load, shall not exceed an amount which will reduce the glass bite below 75% of the design dimension and the member shall have a 3 mm (1/8 in) minimum clearance between itself and the top of the fixed panel, glass, or other fixed part immediately below. The clearance between the member and an operable window or door shall be at least 1.5 mm (1/16 in).

The permissible deflections here specified are the maximums recommended. Smaller limits may of course be specified but in doing so it should be recognized that this may require heavier and more expensive members. Since the depths of horizontal mullions in curtain walls may be relatively shallow, it may not be possible to block glass and/or infill panels at the normally specified quarter points and still maintain reasonable deflection limitations, particularly on wider spans where the heavier glasses are used. When this condition arises the setting blocks may be moved to 150 mm (6 in) from each edge but no closer than 1/8th of the glass width, whichever is greater, and structural calculations should be provided to indicate that the horizontal mullion will deflect no more than the maximum allowed when glass or infill panel is blocked as specified and to verify that the glass panel is structurally adequate for the edge stress imposed because

of the location of the setting blocks. Verification of edge stress on glass is from data based on glass manufacturers' proprietary programs. Glass manufacturers will supply verification upon request.

4. Uniform Structural Loads and Testing Requirements

a. The curtain wall system shall be designed to withstand the design wind pressures specified in 1.07.B.1. Compliance shall be demonstrated by calculations performed in accordance with accepted engineering standards established by AA, AISC, AISI or CDA for the materials being used. (*If actual structural tests are required in lieu of calculations the Architect must include 1.07.B.4.b in the specifications.*)

b. Uniform load structural tests of the curtain wall system shall be conducted in accordance with ASTM E 330. The curtain wall system shall be subjected to inward and outward acting uniform loads equal to 1.5 times the inward and outward acting design wind pressures specified in 1.07.B.1. Satisfactory performance at these loads shall mean no glass breakage, damage to fasteners or anchors, hardware parts or actuating mechanisms; no malfunctioning of windows, doors, and operating hardware; no permanent deformation of main framing members in excess of 0.2% of the clear span.

This test is conducted at 1.5 times the design pressure for the purpose of assuring that the structure has an adequate safety factor. Deflection is not the governing factor in this test. The governing factor is the ability of the unit to withstand the load without damage or permanent deformation in excess of the limits specified. In case of glass breakage during test ASTM E 330 calls for replacement of glass and retest. A second occurrence of glass breakage requires that the framing system be checked for possible weaknesses or faults.

Many curtain wall manufacturers provide standard extrusions for their framing systems. The physical properties of these extrusions have been determined and the connecting and anchoring systems have been tested. Where these standard systems are used, structural calculations made in accordance with accepted engineering practice are sufficient for determining the capabilities of the systems and uniform load deflection and structural tests are not required.

5. Window Cleaning Equipment Loads

a. Continuous Tie-in Guides

Curtain wall framing members serving as continuous tie-in guides for window cleaning equipment shall be designed to carry the following concentrated loads at mid-span:

. . . (A) . . . N (lbs) normal to the plane of the wall representing the equipment load plus 1/3rd of the inward acting design wind load.

. . . (A) . . . N (lbs) applied horizontally parallel to the plane of the wall.

Under these loads the maximum deflection normal to the plane of the wall shall be [1/175 of the clear span] [or] [1/360 for a plastered surface or dry wall subjected to bending by deflection] and the maximum deflection parallel to the plane of the wall shall be . . . (A) . . .

When mechanically operated wall cleaning equipment is to be used, the concentrated loading imposed on guide rail members by such equipment may be a critical design factor. This will be determined by the nature of the equipment. Design data should be obtained from the manufacturer. The load acting normal to the plane of the wall should include the equipment load plus one third of the inward acting design wind load. The mullion design will be governed by this combined load or by the wind load alone, whichever is greater. However, loads imposed by cleaning equipment can be very severe and walls must be carefully engineered to resist them. In view of this the Architect may wish to incorporate a factor of safety in the guide rail load requirements. Allowable stress should be that recommended by AA, AISI, AISC or CDA, whichever is applicable for the metal alloy specified.

Continuous tie-in guides may be eliminated on the curtain wall where the building is provided with equipment tie-in devices located so that the suspended portion of the equipment will not be suspended more than 14 m (45 ft) below any such tie. This is referred to as intermittent stabilization the requirements of which are set forth in the following paragraphs and are covered in ANSI/ASME A39. 1. This method of stabilization limits a suspended platform's horizontal movement with respect to the face of a building by limiting the platforms free suspension between stabilization points.

b. Intermittent Stabilization of Window Cleaning Equipment

Building anchors shall be located in vertical rows with stabilization points at a maximum of every third floor [approximately 12 m (40 ft)] and horizontally in close proximity to the suspension ropes to allow a stabilization attachment for each of two of the platform's suspension wire ropes.

Building anchors shall be located so that they are either both outside or both inside the wire suspension ropes.

Building anchors shall be easily visible to the workers during descent and ascent of the platform. The platform shall be no greater than 10 m (32 ft) in length and 1 m (3 ft) in width.

Each building anchor shall be capable of sustaining a maximum load of 2700 N (600 lbf) parallel to and perpendicular to the face of the building but not applied simultaneously.

This method of stabilization shall be used only when predicted winds will be less than 11 m/s (25 mph). Each building incorporating this method of stabilization shall be equipped with an instrument to measure wind velocities.

6. Drift (Wind or Seismic)

The curtain wall system and its anchorage shall accommodate a lateral drift of . . . (A) . . . mm (in) per floor when subject to the maximum overturning moment of the building due to wind load or seismic load.

The Architect should specify the maximum drift based on the structural engineers calculations.

Drift is the lateral movement of floors relative to each other. In high-rise buildings subjected to high winds the overturning moment may cause movements which must be taken into account in the curtain wall design. Seismic forces referred to in 1.07.B.6 also cause drift. However, for design purposes the wind and seismic forces are not additive but the greater of the two forces is used. The reactions of the curtain wall framing and the anchorage are different for different wind directions and also for different directions of seismic forces. In the case of wind, the top of the framing will move inward at the top of the story on the windward side of the building, it will move outward on the leeward side and it will move laterally in the plane of the wall on sides parallel to the wind. The same kind of movements will occur under seismic loads. System designs must take into account all of these motions.

7. Earthquake Loads

The curtain wall system and its anchorage shall resist the earthquake loads of Seismic Zone . . . (A) . . . in accordance with the requirements of ANSI A58.1

OR

The curtain wall system and its anchorage shall resist the earthquake loads in accordance with the requirements of . . . (A) . . . (Architect specify governing code).

ANSI A 58.1 provides maps for seismic zones in the 48 contiguous states plus Alaska, Hawaii and Puerto Rico. The seismic maps are divided into five zones, 0 through 4. Zone 0 is for areas which experience the lowest earthquake loads with loads increasing as the zone numbers increase. Effective Peak Velocity-Related Acceleration Coefficient (EPV) is related to the damageability of ground shaking. Zone 0 has an EPV of 0.05 or less while Zone 4 has an EPV of 0.40 or more. (The Architect should specify the zone appropriate for the

location of his building). Seismic forces will cause drift or lateral deflection of a story relative to adjacent stories. Curtain walls must accommodate such drift. ANSI requires that the deflection of horizontal resisting elements shall not exceed 0.005 times the story height or 0.0025 in buildings with unreinforced masonry and gives a method for calculating the drift. At the time of publishing this manual, revisions to the seismic requirements of the ANSI standards were being considered. The most current edition of this standard should be consulted when it is used for specifying earthquake loads.

The curtain wall, which is considered a non-structural component, will also be affected by seismic forces. ANSI provides a formula for calculating the lateral forces on curtain wall elements which is based on the Zone, the Occupancy Importance Factor, the Horizontal Force Factor and the Dead Load. Some codes follow the ANSI A58.1 requirements. Others differ: The Architect must as a minimum incorporate the requirements of the governing code.

8. Live Loads

The curtain wall system and its building anchorage shall accommodate a deflection at mid-point between columns of . . . (A) . . . mm (in) caused by uniform and concentrated live loads on floors or horizontal load bearing elements to which the wall is anchored.

In most cases the curtain wall is anchored to the building structure prior to the application of the live loads. Application of these loads to the floor and spandrel beams results in a vertical deflection, up or down, to the surfaces to which the wall is mounted. Such loads will cause deflections which must be accommodated by the curtain wall and its anchorage. Accommodation of greater deflections caused by greater loads requires deeper framing sections which in turn cause greater sight lines.

ANSI A58.1 provides minimum standards for uniform and concentrated live loads. By ANSI definition live loads are those loads produced by the use and occupancy of the building and do not include environmental loads such as wind load, snow load, rain load, earthquake load or dead load. Nor do they include fixed service equipment which is considered dead load.

The Architect should specify the maximum deflection based on the structural engineer's calculations.

C. Air Leakage

1. Air leakage through the curtain wall shall not exceed 0.3 L/s•m² (0.06 cfm/ft²) of fixed wall area plus the permissible allowance specified for operable [windows] [and] [doors] within the test area when tested in

accordance with ASTM E 283 at a static air pressure difference of 75 Pa (1.57 psf).

2. Air leakage through [aluminum windows shall meet the requirements of [ANSI/AAMA 101] [or] [AAMA GS 001] for the window types specified] [and] [aluminum sliding doors shall meet the requirements of ANSI/AAMA 101 for the door types specified].

OR

Air leakage through steel windows shall meet the requirements set forth in SWI's recommended specifications for the window types specified.

OR

Air leakage through [stainless steel] [bronze] [other metal] windows shall meet the requirements set forth in [ANSI/AAMA 101] [AAMA GS 001] [SWI] [Manufacturer's specifications] [other] for the window types specified.

Industry standards do not presently exist for air leakage through swinging doors. If the Architect must specify a performance requirement for such doors he should do so only after consulting manufacturers to be certain that specified values can be met.

D. Water Penetration

1. Water penetration, in this specification, is defined as the appearance of uncontrolled water other than condensation on the indoor face of any part of the wall.

2. Provision shall be made to drain to the exterior face of the wall any water entering the system. Refer to AAMA Aluminum Curtain Wall Series No. 2, "The Rain Screen Principle and Pressure Equalized Wall Design" for more information on defense against water penetration.

3. No uncontrolled water penetration shall occur when the curtain wall is tested in accordance with ASTM E 331. The static air pressure difference used in the test shall be 20% of the inward acting design wind load pressure specified in 1.07.B.1 but not less than 300 Pa (6.24 psf). (Architect specify different pressure if required, see commentary.)

The water test pressure of 20% of the inward acting design wind load pressure is recommended because it should provide satisfactory performance in most parts of the country under the normally prevailing weather conditions. However, there are parts of the country in which the simultaneous occurrence of high winds and heavy rains may be frequent enough to make it desirable to use a higher water test pressure. Conversely, there are areas in the country where the climate is such that a

lesser test pressure could be acceptable. The Architect must make this judgment.

4. No uncontrolled water penetration shall occur when the wall is tested in accordance with AAMA 501.1 using dynamic pressure. (Optional, see commentary.)

Most curtain wall testing for water penetration is done with a static air pressure difference between the outer and inner surfaces of the wall. This is the method specified in ASTM E 331. Subsequent field performance of walls so tested has generally been satisfactory. Occasionally, however, the Architect may develop a wall design incorporating certain features, particularly features having to do with water baffles and drainage, which he wishes to submit to a more turbulent type of test. On such occasions he may wish to specify that the wall be tested under dynamic pressure. In the dynamic test a wind generator, usually a stand mounted airplane engine and propeller, drives a high velocity stream of air against the wall test specimen. The velocity of the air must be high enough to produce a pressure on the test wall equal to that required by the specifications. For information on dynamic testing refer to AAMA 501, "Methods of Test for Metal Curtain Walls."

5. Operable windows shall meet the same requirements for resistance to water penetration as the wall.

OR

Operable aluminum windows shall meet the requirements for resistance to water penetration of [ANSI/AAMA 101] [or] [AAMA GS 001] for the window types specified [and] [aluminum sliding doors shall meet the requirements of ANSI/AAMA 101 for the door types specified]. (See commentary regarding swinging doors.)

OR

Operable [steel] [stainless steel] [bronze] windows shall meet the requirements for resistance to water penetration of [ANSI/AAMA 101] [SWI] [Manufacturer's specifications] [other] for the window types specified.

Industry standards do not presently exist for water penetration through swinging doors. If the Architect must specify a performance requirement for such doors he should do so only after consulting manufacturers to be certain that specified values can be met.

E. Thermal Performance

1. Condensation Resistance

- a. The fixed light area of the curtain wall, including glass and metal framing, shall have a condensation resistance factor, CRF, not less than . . . (A) . . . when tested in accordance with AAMA 1502.7.

- b. [Operable windows] [and] [doors] (if applicable) shall meet the same minimum condensation requirement as the curtain wall.

OR

[Operable windows] [and] [doors] (if applicable) shall have a condensation resistance factor, CRF, not less than . . . (A) . . . when tested in accordance with AAMA 1502.7.

2. Thermal Transmittance

- a. The fixed light area of the curtain wall, including glass and metal framing, shall have a thermal transmittance, U, not exceeding . . . (A) . . . $W/m^2 \cdot K$ ($Btuh/ft^2/^\circ F$) when tested in accordance with AAMA 1503.1.

- b. [Operable windows] [and] [doors] (if applicable) shall meet the maximum thermal transmittance requirement for the fixed light area of the curtain wall.

OR

[Operable windows] [and] [doors] (if applicable) shall have a thermal transmittance, U, not exceeding . . . (A) . . . $W/m^2 \cdot K$ ($Btuh/ft^2/^\circ F$) when tested in accordance with AAMA 1503.1.

- c. Opaque insulated panel of the wall shall have a thermal transmittance, U, not exceeding . . . (A) . . . $W/m^2 \cdot K$ ($Btuh/ft^2/^\circ F$) when tested in accordance with [AAMA 1503.1] [or] [ASTM C 236] [or] [ASTM C 976].

- d. Average calculated thermal transmittance of the composite wall shall not exceed a U-value of . . . (A) . . . $W/m^2 \cdot K$ ($Btuh/ft^2/^\circ F$). Where required, U-values of components shall be determined by [AAMA 1503.1] [or] [ASTM C 236] [or] [ASTM C 976].

Thermally insulated metal framing systems are available in a number of different types. These systems reduce heat loss experienced with non-insulated systems and solve the problem of cold interior metal surfaces on which water vapor from the relatively humid inside air condenses. However, in many curtain walls the glass area far exceeds the metal area so that the insulating glass chosen for such walls will be the major determinant of performance limits on heat loss and condensation. Nevertheless, the metal framing area is still significant and its thermal performance should not be neglected, particularly with regard to condensation resistance. Condensate running off of the framing to the interior areas would be highly undesirable and could cause damage. For information on this subject refer to AAMA Aluminum Curtain Wall

Series No 9, "Design for Energy Conservation in Aluminum Curtain Walls."

F. Light Transmission (If glass and glazing are part of this Section)

The glazed areas of the curtain wall shall meet the following requirements:

Light transmittance, average daylight	... (A) ...%
Light reflectance	... (A) ...%
Shading coefficient	... (A) ...

Glass and plastic sheet manufacturers have extensive literature available on the performance of their products. AAMA Aluminum Curtain Wall Series No. 6, "Glass and Glazing," contains more pertinent technical data published by glass manufacturers. The Architect is referred to this publication for such data. Information on glass and on the properties and use of acrylic and polycarbonate sheet for glazing is given in the Technical Data Section of these Guide Specifications. Manufacturers should be consulted directly if necessary to establish specifications which will assure the desired performance.

G. Sound Transmission (Optional)

The average sound transmission loss through the metal framed glass and panel areas of the curtain wall shall be a minimum of ... (A) ... dbA for the standard frequency range of 125-4,000 hertz when tested in accordance with ASTM E 90.

OR

The average sound transmission loss through the metal framed glass and panel areas of the curtain wall shall be a minimum of ... (A) ... dbA for the frequency range of ... (A) ... hertz when tested in accordance with ASTM E 90.

Standard sound tests are conducted in the frequency range of 125-4,000 hertz. However, if the building location is near an airport, on a heavily traveled highway, or near some other major noise source, special requirements for performance at different frequencies may be necessary. The special requirements would be determined by making appropriate sound measurements at the proposed building site.

In a performance-type specification the sound level of the building interiors will be established and from this, taking into consideration special requirements, the sound transmission loss for the wall will be specified. In this type of specification, A-weighted sound levels, dbA, are used. These are measured on a sound level meter having a frequency response tailored to meet the requirements of ANSI Standard S1.4 for Sound Level Meters. The A-weighted sound levels have been found to give good

correlation with human subjective response for a very wide variety of sound types and levels and the use of dbA is being adopted for many noise codes, ordinances and standards.

Windows, doors and glazing are sometimes tested in accordance with ASTM E 90 and given an STC number instead of an average sound transmission loss or STL rating. STC is the Sound Transmission Class of a product or material and is determined in accordance with the procedures of ASTM E 413. It provides a single number rating for describing the degree of acoustical control and can be used to compare building products or materials. The rating is designed to correlate with subject impressions of the sound insulation provided against the sounds of speech, radio, television, music, office machines, and similar sources of noise in offices and dwellings. It is used in making comparisons of different glazing systems. Excluded from the scope of the STC classification system are applications involving noise spectra that differ markedly from these types of noise sources. A particular exclusion is the exterior walls of buildings for which noise problems are most likely to involve motor vehicles or aircraft. Estimates for the acoustical properties of exterior glazing and panels should be based on data from the entire Sound Transmission Loss, STL, curve and is particularly important for walls designed to significantly reduce the levels at very specific frequencies of intruding noise.

Refer to Glass in the Technical Data Section of these specifications for more information on sound transmitting properties of glass. Reference may also be made to AAMA Technical Information Reports TIR-A1-1975 entitled, "Sound Control for Aluminum Curtain Wall and Windows." In addition, valuable information will be found in a publication of the Sealed Insulating Glass Manufacturers Association entitled, "Technical Manual for Acoustical Glass."

H. Fire Resistance Requirements

1. Performance of panels under fire or high temperature exposure shall be ... (Architect specify requirements) ... Tests need not be conducted if materials and products to be used have been tested and can be certified to meet these requirements. If tests are required they shall be conducted in accordance with the procedures listed below.

- Non-Combustibility - ASTM E 136
- Flame-Spread - ASTM E 84
- Fire Resistive Rating - ASTM E 119 or a modified ASTM E 119 procedure as follows:

The spandrel panel must be designed and anchored in a manner that it will stay in place and prevent passage of smoke, flame and hot gases for the requisite fire exposure period when exposed to the ASTM E 119 time temperature curve.

Although there is no standard test procedure or test criteria for establishing fire resistive ratings for curtain walls, the acceptance of a particular panel or curtain wall design to meet fire rating requirements is usually met by submitting various test data and evidence to the building code official. The Architect should determine the requirements and specify them in this paragraph. What is needed is evidence that the panel and the materials of which it is composed are non-combustible, i.e., will not burn or contribute a significant quantity of combustibles under fire exposure. Ability of the materials to meet the appropriate tests is evidence that they will perform satisfactorily in the curtain wall.

The testing of curtain wall panels is not anticipated or covered in ASTM E 119. Consequently, it is only practical to test protected glass, metal or other spandrel panels by use of a modified ASTM procedure, the recognition of which must be negotiated with the governing code agency.

2. Fire stops and safing insulation shall be provided between the interior wall surface and the building structure as shown on the Architect drawings.

If the opening between the floor slab and the curtain wall is not closed, fire may spread from floor to floor in a high-rise building. The means of providing a fire stop is often referred to as, "safing off." The "safing" material may be any non-combustible material which will prevent passage of flames or hot gases for whatever time period is established by a particular building code or building official.

More information on fire safety in high-rise buildings is published in AAMA Aluminum Curtain Wall Series No. 5, "Fire Safety in High-Rise Curtain Wall Buildings," and in AAMA Technical Information Report TIR-A3-1975 entitled "Fire Resistance Design Guidelines for Curtain Wall Assemblies."

I. Field Test for Air Leakage (Optional)

Field test for air leakage shall be conducted in accordance with ASTM E 783 at a static air pressure difference of . . . (A) . . . Pa (psf) in the area(s) indicated on elevation drawing(s) . . . (A) . . . Maximum allowable rate of air infiltration shall not exceed . . . (A) . . . L/s•m² (cfm/ft²) of wall area.

This test was developed primarily for evaluating the performance of installed windows and doors. It may also be used to test sections of curtain walls providing the wall design and installation permit the proper application of the test equipment and instrumentation. There may be conditions which will preclude the satisfactory conduct of an air leakage test on an installed wall. Consultation with an accredited laboratory is recommended where questions may exist regarding a satisfactory air leakage test. See commentary following 1.07.J.1 about field performance versus laboratory performance.

J. Field Test for Water Leakage (Optional)

1. Static Air Pressure Difference Test

Field test for water penetration shall be conducted in accordance with ASTM E 1105 at a uniform static air pressure difference of . . . (A) . . . Pa (psf) on the area(s) indicated on elevation drawing(s) . . . (A) . . . There shall be no water penetration as defined in 1.07.D.1 of this specification.

For new construction it is recommended that the field test be made as soon after installation has started as is practical. However, the test must be made on a completed area of the curtain wall and the area to be tested should be designated by the Architect. An advantage of testing early during installation is that errors in fabrication or installation can be found and corrections made before the entire wall is installed at which point the expense of making corrections could be much greater.

Generally it is possible to conduct the field test on window and door assemblies without too much difficulty and to identify sources of leakage. A curtain wall assembly, on the other hand, may not be accessible from the inside without the removal of interior finished walls and ceilings. The feasibility of conducting a meaningful static air pressure difference water penetration test on an in-service building should be carefully evaluated before being specified.

Installed performance will generally be somewhat less than laboratory performance because of manufacturing tolerances, installation tolerances and the difficulty which may be encountered in carrying out precise field tests. At present there are no AAMA standards for field performance. AAMA recommends that specifiers confer with manufacturers and/or curtain wall consultants before establishing installed performance requirements.

2. Water Spray Test Without Air Pressure Differences

Upon completion of the installation of the wall framing and/or units on the lower two typical floors of the building and with at least 230 mm (75 lineal feet) of this two-story height fully glazed, the wall shall be checked for water penetration in accordance with AAMA 501.2, "Field Check of Metal Curtain Walls for Water Leakage". The Architect will designate an area of the completed wall, two bays in width and two stories in height to be so checked.

This is not a performance test as is the test conducted with static air pressure difference as specified in 1.07.J.1. Its purpose is to check the resistance to water penetration of the permanently closed joints of the wall, not the operable joints around windows or doors. The check has been successfully used by wall installation contractors in early stages of construction and has become a standard practice with a number of them. It is a relatively

inexpensive means of verifying that the wall as actually installed is not vulnerable to water leakage.

K. Other Performance Requirements and Tests

(List any not previously specified which may be needed to ensure the desired total performance of the wall system.)

1.08 QUALITY ASSURANCE

A. Qualifications

1. Welding shall be done by skilled and qualified mechanics licensed where required in accordance with local building regulations. Welding shall be in conformance with AWS Structural Welding Code D1.1 for steel and D1.2 for aluminum.

2. Testing Laboratories shall be specifically qualified to conduct laboratory and field performance tests required by these specifications.

3. Laboratory performance tests for [air leakage] [water penetration] [deflection] [structural] [condensation resistance] [thermal transmittance] [sound transmission] [fire resistance] [other] shall be made by [AAMA Accredited Laboratories] [and/or] [other qualified laboratories].

4. Field performance tests for [air leakage] [water penetration] shall be made by [AAMA Accredited Laboratories] [other qualified laboratories].

(List the laboratory and field performance tests specified in 1.07 in 3 and 4 above and designate qualified laboratories.)

AAMA Accredited Laboratories are qualified to conduct performance testing for air leakage, water penetration, deflection and structural strength. Some of these laboratories are also qualified to conduct condensation resistance, thermal transmittance and other performance tests. A current listing of Accredited Laboratories is available from AAMA.

5. Performance tests conducted in the Wall Contractor's Laboratories shall be performed by accredited laboratory personnel or witnessed and certified by a qualified Professional Engineer.

6. Any or all tests may be waived provided test reports, prepared by recognized testing agencies or certified by independent Professional Engineers, are submitted showing that the curtain wall, windows, doors and other components or acceptable facsimile thereof, have met or exceeded all performance requirements. Certification of compliance with a standard by a recognized testing agency is also acceptable in lieu of testing.

B. Mock-ups *(Optional alternative selections; select one)*

No full-size mock-ups of any kind are required. If it should appear later that such are desirable, the costs involved will be negotiated, and will be considered as extra.

OR

All necessary labor and materials shall be supplied to build on . . . *(state location)*. . . full-size mock-up(s) of . . . *(identify parts of wall to be included)* . . .

If one or more mock-ups is required (2nd alternative), the Architect should specify the size, the materials to be used, their intended purpose and the disposition to be made of materials after use, providing all information necessary for the Contractor to determine the costs involved. Unless specifically so stated, no mock-ups of any kind should be expected from the Wall Contractor.

Mock-ups may range in complexity and cost from a simple, full-size corner assembly to a large, functional portion of the wall system. Generally mock-ups are built for testing purposes so it is necessary not only that the exact size and configuration be specified but also that its end use and ultimate disposition be clearly defined. (A good practice, often used by the Architect, is to block out a typical mock-up area on one elevation of the architectural drawings and note it as being representative of the size and type of mock-up required.) In order for the Curtain Wall Contractor to establish his costs it is necessary that the Architect state where the mock-up will be erected (at building site, at testing laboratory, at manufacturer's testing facilities, etc.), what materials and finishes will be required on the total mock-up and the number and types of tests required.

To avoid problems in fabrication, installation and performance testing of mock-ups should be completed and satisfactory results obtained prior to release of the wall for production. Testing, therefore, should be scheduled well in advance of the need for wall materials on the job.

1.09 SUBMITTALS

A. Shop Drawings

. . . (A) . . . copies of all shop drawings shall be submitted to the Architect for approval. Drawings shall show scale elevations and sections. Full-scale sections shall be shown only when needed for clarity. Drawings shall include, where required, a hardware schedule, a key to sheet metal and glass thicknesses, metal finishes and all pertinent information. Details of field connections and anchorage and their relationship to the work of others shall be clearly indicated when necessary to coordinate the work with other building trades. Details of fastening and sealing methods and product joinery shall be shown only when necessary to ensure the proper performance of the field

installation and may be submitted in the form of the manufacturer's printed literature. No work shall be fabricated until shop drawings for that work have been approved for fabrication.

(Architect indicate number of copies required)

B. Samples

Before any work is fabricated, the following samples, properly identified, shall be submitted to the Architect for approval:

Samples required should be listed, giving the minimum size of each and explaining any specific details to be represented. Samples should carry a label showing the supplier's name, the date and identifying information indicating what the sample represents.

Where color is involved the Architect should specify the number of sets of color range samples to be submitted for his approval. Samples should carry labels as noted above with space for approval and date of approval. After approval, the Architect will return two sets to the Wall Contractor and retain the remaining sets for his guidance. Approvals are required before any work is fabricated.

C. Structural Calculations

Copies of any structural calculations made by or for the Wall Contractor in connection with supplementary design and/or detailing of the work herein specified shall be submitted to the Architect if requested.

The Architect is responsible for defining structural performance requirements for the curtain wall in 1.07.

D. Test Reports

Copies of certified test reports on the performance of standard wall systems and components shall be submitted to the Architect on request in lieu of conducting repeat tests.

E. Certification and Labeling

When the performance standards of a product certification and labeling program satisfy the requirements of 1.07, products bearing AAMA "Quality Certified", SGCC, UL, or other such labels, will require no testing.

1.10 IDENTIFICATION, DELIVERY, STORAGE AND HANDLING OF MATERIALS

A. Conform to requirements of Section 016 _____

If project specifications include a section in Division 1 establishing the general requirements for Delivery, Storage and Handling of materials and equipment for the project, include A, above, and modify following paragraphs to avoid duplication.

B. All components of the wall shall be identified after fabrication by marks clearly indicating their location on the building as shown on the drawings. Packaging, if necessary, shall be the minimum necessary to protect the parts from damage during shipping and hoisting.

C. Predesignated storage spaces shall be provided by the General Contractor on each floor, as required, so that the stored materials will not be exposed to damage from wetting, traffic or operations of other trades. The Wall Contractor shall not be required to move his materials except as needed to install the wall.

D. Storage on Site:

1. Store material in a location and in a manner to avoid damage. Stacking shall be done in a way which will prevent bending, excessive pressure or abrasion of the finished surfaces.

2. Store aluminum, bronze and stainless steel components and materials in a clean, dry location, away from uncured concrete and masonry. Cover with waterproof paper, tarpaulin or polyethylene sheeting in a manner that will permit circulation of air inside the covering.

E. Keep handling on-site to a minimum. Exercise particular care to avoid damage to finishes of materials.

For carbon steel, reference should be made to the Code of Practice of the latest edition of the AISC Manual of Steel Construction on delivery and erection. For aluminum, refer to AAMA Aluminum Curtain Wall Series No. 10, "Care and Handling of Architectural Aluminum from Shop to Site."

1.11 WARRANTY

A. The Curtain Wall Contractor shall warrant for . . . (A) . . . years from the date of substantial completion of the work related to [curtain wall] [windows] [doors] [other components] that the work is not defective in workmanship or materials and conforms to the final, approved shop drawings except for reasonable variances not impairing the usefulness thereof. This warranty applies to both patent and latent defects but does not include damage caused by acts of God, ordinary wear and tear or, unusual abuse or neglect, or the acts of omissions of parties other than this Contractor. This warranty is in lieu of all other warranties expressed or implied.

Manufacturers normally warrant their products for one year. Requests for extended warranty times may result in an additional charge.

PART 2 — PRODUCT

2.01 METALS

Refer to the Technical Data Section of this manual for guidance in the selection of metals.

A. Metals Schedule

Metals as specified in this paragraph and their finishes as specified in 2.04 shall be supplied in accordance with the schedule set forth in the Architect approved drawings.

B. Aluminum Alloys

1. Standard alloys shall conform to the requirements published in the Aluminum Association's, "Aluminum Standards and Data," and to the following standards:

Sheet and plate.....	ASTM B 209
Extruded bars, rods, shapes and tubes.....	ASTM B 221
Bars, rods and wire	ASTM B 211
Standard structural shapes.....	ASTM B 308
Drawn seamless tube.....	ASTM B 210
Extruded structural pipe and tubes.....	ASTM B 429
Sand castings.....	ASTM B 26
Permanent mold castings.....	ASTM B 108
Die castings.....	ASTM B 85
Welding rods and bare electrodes.....	AWS A5.10

6063-T5, 6063-T52, and 6063-T6 aluminum alloy and tempers are almost universally used for curtain wall framing. The T5 and T52 tempers provide minimum yield strength of 110 MPa (16,000 psi) whereas T6 provides minimum yield of 172 MPa (25,000 psi). The alloy and temper designations are those of The Aluminum Association. 6061-T6 and 6105-T5 have a minimum yield strength of 241 MPa (35,000 psi) and are excellent for structural shapes where anodizing is not required. Both alloys meet the requirements of ASTM B 221. 1100 and 5005 sheet and plate alloys are suitable for anodizing and provide good appearance match with 6063 extrusions. 1100 and 5005 alloys meet the requirements of ASTM B 209.

2. Specialty alloys . . . (A) . . . produced by . . . (name producer) . . . shall be processed under controlled conditions prescribed by the producer to provide minimum mechanical properties called for by the design and to produce the specified color anodized finish.

Colors ranging from light to dark bronze to black can be obtained with sheet and extrusion alloys. Specialty alloys are available where special requirements for integral color anodized finishes exist. Fabricator and producers should be consulted regarding the specification of such alloys.

C. Copper Alloys

1. Standard alloys shall conform to the requirements published in the Copper Development Association's, "Standards Handbook, Copper, Brass and Bronze."

Alloy No. 385 (Architectural Bronze) extrusions meeting ASTM B 455 for shapes.

Alloy No. 230 (Red Brass, 85%) extrusions meeting ASTM B 43 for pipe.

Alloy No. 280 (Muntz Metal, 60%) for sheet.

The above alloys are the most commonly used for architectural work. However, many other standard alloys are available.

2. Specialty alloys . . . (A) . . . produced by . . . (name producer) . . . shall be processed under controlled conditions prescribed by the producer to provide the mechanical and appearance properties required.

D. Carbon Steel

Carbon steel alloys shall conform to the requirements published in the American Iron and Steel Institute's Steel Products Manual and to the following standards:

Structural shapes, plates and bars.....	ASTM A 36
Sheet and strip, cold rolled, structural quality, (Grades A through E).....	ASTM A 611
Sheet and strip, hot rolled, structural quality, (Grades A through E).....	ASTM A 570
Sheet for porcelain enameling.....	ASTM A 424
Sheet, hot dipped galvanized, structural quality, (Grades A through F).....	ASTM A 446
Sheet, electrolytic zinc coated.....	ASTM A 591

High strength, low alloy steel shall conform to the requirements published in the American Iron and Steel Institute's Steel Products Manual and to the following standards:

Structural shapes, plates and bars, columbium-vanadium grades.....	ASTM A 572
Sheet and strip, columbium-vanadium grades.....	ASTM A 607
Structural tubing, hot formed, welded and seamless.....	ASTM A 618

High strength low alloy steel can be used advantageously in any structural application where its greater strength can be utilized to either decrease the weight or increase the durability.

E. Stainless Steel

Stainless steel shall conform to the requirements published in the American Iron and Steel Institute's Steel Products Manual and to the following standards:

Plate, sheet and strip (Types 409, 410, 430).....	ASTM A 176
Sheet, strip, plate and flat bar for architectural structural applications (Types 201, 202, 301, 302, 303, 304, 316 in Grades A through D).....	ASTM A 666
Tubing, seamless and welded (Types 409, 410, 430).....	ASTM A 268
Tubing, seamless and welded (Types 304, 304L, 316, 316L).....	ASTM A 269

Types 302 and 304 are the most common types used architecturally both for interior and exterior applications. They have very good corrosion resistance, good wearing qualities, high strength, readily formed and weldable.

Type 316 is similar to 304 but with increased corrosion resistance. This type should be specified for use in extremely corrosive atmospheres.

Type 430 has good atmospheric corrosion resistance, but not as good as 304. This type is generally used for interior architectural applications, trim and hardware items.

F. Patterned Metal Sheets

Overall relief pattern(s) in . . . (name metal) . . . sheets used as shown in the schedule on the drawings shall be . . . (name pattern) . . . as produced by . . . (name manufacturer) . . .

This clause refers to the many embossed or texturized patterns available in the smaller thicknesses of all of the architectural metals. Patterns are impressed by special rolls, some deforming both sides of the sheet and others only one side. As sheet widths are limited by the manufacturer's equipment, the available width of pattern chosen may often be an important consideration.

2.02 FASTENER METALS FOR JOINING VARIOUS METAL COMBINATIONS

(Note: Fastener metals are listed in order of preference)

When dissimilar metals become wet from rain, condensation or other source, galvanic action occurs. This establishes a condition conducive to the corrosion of one of the two metals in contact. As indicated, the metals shown in the paragraphs below are arranged in the order of preference. The metals at the beginning of the lists, when used as fasteners, will provide the best resistance to corrosion. The metals at the end of the lists will provide least resistance, with resistance decreasing in order of listing. For conditions encountered in most parts of the country the fastener metals listed will usually give satisfactory performance. For severe conditions, such as those which may be encountered in sea coast areas, the metal providing the best corrosion resistance is recommended.

A. Aluminum to Aluminum

1. Fasteners used to join aluminum to aluminum shall be [aluminum] [stainless steel] [zinc plated steel] [cadmium plated steel].

B. Aluminum to Stainless Steel or Carbon Steel

1. Fasteners used to join aluminum to stainless steel or carbon steel shall be [stainless steel] [zinc plated steel] [cadmium plated steel].

C. Copper Alloys to Copper Alloys

1. Fasteners used to join copper alloys to copper alloys shall be [bronze] [brass] [nickel-silver] [stainless steel].

D. Copper Alloys to Aluminum

1. Fasteners used to join copper alloys to aluminum shall be stainless steel.

2. Prior to joining apply protective material to metals to prevent metal to metal contact.

(Note: Joining of these metals is not recommended. See commentary. If mandatory, a suitable protective material must be applied to resist galvanic corrosion.)

E. Copper Alloys to Stainless Steel

1. Fasteners used to join copper alloys to stainless steel shall be [stainless steel] [bronze] [brass].

F. Copper Alloys to Carbon Steel

1. Fasteners used to join copper alloys to carbon steel shall be [bronze] [brass].

G. Carbon Steel to Carbon Steel

1. Fasteners used to join carbon steel to carbon steel shall be [stainless steel] [cadmium plated or zinc plated steel] [nickel plated steel] [chrome plated steel] [carbon steel].

H. Stainless Steel to Stainless Steel

1. Fasteners used to join stainless steel to stainless steel shall be stainless steel.

I. Fastener Metal Alloy Types, Designations and Standards

1. Stainless steel fasteners shall be made of the following alloy:

- a. For exterior exposure, Type [302] [303] [304] [316] [430].

b. For interior exposure, Type [302] [303] [304] [316] [410] [430].

Designations for stainless steel alloy types are those of AISI.

(Select the alloy appropriate to the exposure and environment)

The 300 series alloys have superior corrosion resistance to the 400 series and are recommended where fasteners are exposed to severe conditions. Information on the specific properties of the different alloys is available from AISI.

2. Copper alloy fasteners shall be made of the following alloy:

a. Bronze, [No. 651, Low Silicon B] [No. 655, High Silicon A].

b. Brass, [No. 260, Cartridge, 70%] [No. 280, Muntz Metal, 60%] [No. 360, Free Cutting] [Nos. 464, 465, 466 and 467 Naval] [No. 485, Naval, High Leaded].

c. Nickel-Silver, No. 745.

Designations for copper alloys are those of CDA.

Information on the specific properties of the different alloys is available from CDA.

3. Metallic coated carbon steel fasteners

a. Zinc plated fasteners shall meet the requirements of ASTM B 633 for Class FE/ZN 5, 5 µm coating thickness, service condition SC 1 (mild), with Type 111 finish meeting corrosion resistance requirements after a 12 hour salt spray test.

OR

Zinc plated fasteners shall meet the requirements of ASTM B 633 for Class FE/ZN 8, 8 µm coating thickness, service condition SC 2 (moderate), with Type 11 finish meeting corrosion resistance requirements after a 96 hour salt spray test.

Class FE/ZN 8 should be specified where atmospheric conditions are, more severe.

b. Cadmium plated fasteners shall meet the requirements of ASTM B 766 for Type TS coating, 5 µm thick.

OR

Cadmium plated fasteners shall meet the requirements of ASTM B 766 for Type OS coating, 8, µm thick.

Type OS coating should be specified where atmospheric conditions are more severe.

The performance of both zinc and cadmium coatings depends largely on their coating thickness and the kind of environment to which they are exposed. Without proof of satisfactory correlation, accelerated tests, such as the salt spray test, cannot be relied upon to predict performance in other environments, nor will the tests serve as comparative measures of the corrosion protection afforded by the two different metals. Thus the superiority shown by cadmium coatings over zinc coatings of equal thickness in the standard salt spray test cannot be construed as proof that this will hold true in all atmospheric environments.

c. Nickel or chrome plated fasteners shall meet the requirements of ASTM B 456.

4. Aluminum fasteners shall be made of the following alloys:

a. Screws and bolts, alloy [2024] [6061].

b. Nuts, alloy [6262].

c. Rivets, alloy [1100] [6053] [6061].

Designations for aluminum alloys are those of AA.

For information on the selection of aluminum alloys refer to the Technical Data Section of this manual.

2.03 PROTECTIVE MATERIALS FOR METALS

A. Protective materials for metals where called for shall conform with the standards listed here or be of the brand specified by the Architect.

Paint systems for carbon steel should follow the specifications of the Steel Structures Painting Council, SSPC. This council has established environmental zones which define the atmospheric conditions to which the painted steel will be exposed. For exterior curtain wall systems one of the following three zones would normally be applicable:

Zone 1B - Exteriors, normally dry.

Zone 2A - Frequently wet by fresh water. Involves condensation, splash, spray or frequent immersion.

Zone 2B - Frequently wet by salt water, Involves condensation, splash, spray or frequent immersion.

1. Painting for carbon steel with following exposure:
(Architect select appropriate environmental zone)

a. Environmental Zone 1B

Oil base painting systems SSPC-PS 1.04 and 1.07 through 1.13
Three-coat latex painting system SSPC-PS 18.01

b. Environmental Zone 2A

Vinyl painting systems SSPC-PS 4.01 through 4.05
Coat tar epoxy-polyamide painting system SSPC-PS 11.01
Epoxy-polyamide painting system SSPC-PS 13.01
Chlorinated rubber painting systems SSPC-PS 15.00

c. Environmental Zone 2B

One-coat zinc rich painting system SSPC-PS 12.01
Vinyl painting systems SSPC-PS 4.01 through 4.05
Coal tar epoxy-polyamide painting system SSPC-PS 11.01
Epoxy-polyamide painting system SSPC-PS 13.01

Reference should be made to the SSPC, Steel Structures Painting Manual Volume 1, "Good Painting Practice," and Volume 2, "Systems and Specifications" for information on selecting and specifying paint systems for carbon steel.

2. Galvanizing of Carbon Steel:

- a. Steel sheets..... ASTM A 526
- b. Hot dip for shapes, plates, bars and strip ASTM A 123
- c. Electro-galvanizing..... ASTM B 633
- 3. Cadmium plating..... ASTM B 766 Type NS
- 4. Zinc chromate primer..... FS TT-P-645A
- 5. Metal-and-masonry paint..... (Architect specify brand)
- 6. Mastic bulk compound.....
..... FS SS-C-153 [Type I] [or] [Type II]
- 7. Preformed mastic tape..... AAMA 804.1
- 8. Aluminum paint..... FS TT-P-38
- 9. Clear protective coatings..... suitable clear lacquer

Clear lacquer is used mainly on bronze. It can be used on anodized aluminum to provide some degree of protection against alkaline building materials such as mortar, cement, plaster and fire insulation or run-off water containing some amounts of any of these materials. Curtain wall manufacturers prefer not to use lacquer because of other problems it may cause. It must be removed from surfaces to which sealants are to be applied in order to achieve the required adhesive to the substrate. Lacquers may also tend to weather differentially, thereby causing appearance problems. It should not be specified for aluminum unless the manufacturer and the purchaser determine that there is definitely a need for it.

- 10. Strippable covering Fabricator use appropriate covering for protection during fabrication only. Remove prior to outdoor exposure.

(Other materials, if any, to be specified in the same manner)

Although many of the metals are not subject to rusting under normal weather exposure, they are still vulnerable to corrosion when in contact with other metals and/or masonry materials. When dissimilar metals are in contact in the presence of moisture, which may be rain water or condensation containing impurities, corrosion is an ever present hazard necessitating protective measures.

2.04 FINISHES

A. Aluminum

1. Aluminum components shall be finished in accordance with the designations and proprietary identifications set forth in the schedule on the drawings referred to in 2.01.A.

2. Designations refer to the finishes defined in The Aluminum Association Designation System for Aluminum Finishes, DAF-45.

3. Anodic Coatings

a. The finish shall meet the quality requirements for Architectural Class [I] [or] [II] anodic coating as described in The Aluminum Association Standards for Anodized Architectural Aluminum, SAA-46.

SAA-46 specifies minimum quality requirements and conformance tests for decorative and protective anodic coatings on aluminum alloys for architectural applications. Two classes of anodic coatings are covered:

Architectural Class I — Anodic coatings for exterior surfaces requiring little or no maintenance.

Architectural Class II — Anodic coatings for interior and maintained exterior surfaces.

Test methods and pass/fail criteria are detailed in SAA-46.

b. Anodic coatings shall meet the requirements of ... (A) ...

The Aluminum Association Designation System for Aluminum Finishes, DAF-45, provides a format for describing the anodic finish needs for a specific project. The system is designed for all types of aluminum products and includes many selections not appropriate for architectural products. The finishes found to be most applicable to curtain wall use are:

<i>Class I</i>	<i>Class II</i>	
<i>18 micron (0.7 mil) minimum</i>	<i>10 micron (0.4 mil) minimum</i>	<i>Description</i>
<i>AA-M12C22A41</i>	<i>AA-M12C22A31</i>	<i>Clear</i>
<i>AA-M12C22A42</i>	<i>AA-M12C22A32</i>	<i>Integral Color</i>
<i>AA-M12C22A44</i>	<i>AA-M12C22A34</i>	<i>2-Step Color</i>

AA identifies the designation with The Aluminum Association. M12 stands for non-specular, as fabricated, mechanical finish. C22 means the metal receives a medium matte alkaline etch prior to anodizing.

A42 and A32 are produced in various shades of bronze and black through the use of special electrolytes that cause the color to be produced during anodizing.

A44 and A34 are produced in essentially the same colors by the 2-step process in which the electro-deposition of metal salts in the pores of a clear anodic coating develops the color.

Since the same colors are produced by these two processes, some specifiers employ the designation A42/A44 or A32/A34 to indicate that they have no preference as to which process is used.

c. Color shall be . . . (A) . . . and fall within the range of architect approved samples on all significant surfaces.

Many manufacturers have established color ranges for their own products. Since there are no recognized industry-wide color standards, when more than one manufacturer is supplying material on a project one of them should be designated the master and be responsible for providing color range samples to the other suppliers, as well as to the Architect.

4. Painted Aluminum

a. All exposed surfaces of aluminum shall be factory painted in accordance with the requirements specified under Organic Coatings in 2.04.E.

B. Copper Alloys

1. Copper alloy components shall be finished in accordance with designations and proprietary identifications set forth in the schedule on the drawings referred to in 2.01.A.

2. Designations refer to the finishes defined in NAAMM's, "Metal Finishes Manual" for copper alloys.

3. Pretreatments shall be those specified in the finish designation schedule and shall match the Architect approved samples.

4. Finish shall be developed by . . . (*describe treatment*) . . . so as to produce a color within the range of the Architect approved samples as per 1.09.B.

5. A clear organic coating. . . (*specify type*) . . . shall be applied to the finished components.

An air drying acrylic lacquer having the INCRALAC formulation is recommended by the CDA.

C. Carbon Steel

1. Carbon steel shall be finished in accordance with the schedule set forth on the drawings referred to in 2.01.A.

2. Pretreatments shall be selected to provide the proper surface for the required applied coating [or] . . . (*specify particular type of pretreatment*). . .

3. Exposed parts shall be finished in accordance with the requirements specified in [2.04.E for organic coatings] [or] [2.04.F for porcelain enamel coatings].

4. Concealed parts shall be protected with . . . (*specify coating*) . . . meeting the requirements of the standard listed in . . . (A) . . . (*Architect select appropriate paragraph(s) from 2.03*)

Information on the finishing of carbon steel may be found in NAAMM's, "Metal Finishes Manual" and in SSPC "Steel Structures Painting Manual" Volumes 1 and 2.

D. Stainless Steel

1. Stainless steel components shall be finished in accordance with designations and proprietary identifications set forth in the schedule on the drawings referred to in 2.01.A.

2. Designations refer to the standard mechanical finishes defined by the American Iron and Steel Institute for stainless steel.

3. Finishes shall match the Architect approved samples per 1.09.B.

E. Organic Coatings

Organic coatings are used primarily on aluminum and steel. Except for clear organic coatings used to protect copper alloy finishes, organic coatings are not generally applied to the copper alloys or stainless steel. The AAMA specifications referenced below in 2.04.E.3 and 4 are for aluminum. For steel or other metals, when organic coatings are to be specified, the manufacturer should be consulted. The Structural Steel Paint Council is an excellent source for information on organic coatings for steel. See 2.03.A on Protective Materials for Metals.

1. Pigmented organic coatings for extrusions, structural shapes, sheet or plate, spray applied in the factory, shall meet the performance requirements of [AAMA 605 (or 603) for aluminum] . . . (A) . . . (List specification for other metal if required)

Organic coatings meeting the requirements of AAMA 605 are high performance materials capable of passing a five year outdoor exposure test in South Florida. These coatings are recommended for applications where good weather resistance and color retention are of primary importance. Fluorocarbon paints will meet this specification. AAMA 605 includes pretreatment, test procedures and pass/fail criteria.

AAMA 603 covers a broad range of coating materials used on building products from screen doors to curtain walls. The upper end of the range only, which includes siliconized polyesters, acrylics and urethanes, should be specified for curtain wall use.

2. Organic coatings shall . . . (list types with description and color) . . .

It is useful to employ a standardized color identification system, manufacturer's chips or descriptive language to specify color.

3. Pretreatment of metal surfaces shall be done in accordance with the procedure [prescribed in AAMA 605 (or 603) for aluminum] [recommended by the paint manufacturer (for other metals)] so as to provide the proper surface for applying the specified coating.

4. Pigmented organic coatings for sheet, applied in the factory by the coil coating process, shall meet the performance requirements of [AAMA 1402, high performance coatings (or standard commercial coatings) for aluminum]. . . (A) . . . (List specification for other metal if required.)

Organic coatings meeting the requirements of AAMA 1402, high performance coatings are recommended for applications where good weather resistance and color retention are of primary importance. These coatings have the same weathering properties as those specified in AAMA 605.

AAMA 1402, standard commercial coatings have similar performance requirements to AAMA 603. These coatings cover a broad range of applications but only those in the upper range, such as siliconized polyesters, acrylics and urethanes should be specified for curtain wall use.

5. The color shall be . . . (A) . . . and all finishes shall match in gloss and fall within the color range of the Architect approved samples per 1.09.B. (Specify the color required and state if it is custom or a standard color

selected from a paint manufacturer's card. Identify with name and/or number.)

Sometimes a specifier may wish to use a finish on the interior surface which is different from that on the outside. It may be a different color, a different quality or both. In such cases the two areas should be treated separately with a specification written for each. The specifier should be careful to determine if the products being used on the project are adaptable to combination finishes before selecting that option.

F. Porcelain Enamel

1. Pretreatment of the metal surfaces shall be done in accordance with the recommendations of the Porcelain Enamel Institute for the metal specified.

2. Porcelain enameling shall conform to PEI specification . . . (A) . . . (Insert the PEI specification appropriate for the metal. For steel it is S-100.)

2.05 CURTAIN WALL SYSTEM

A. Curtain wall units and components shall be produced in accordance with the Architect approved drawings and the schedule set forth thereon.

B. Metal framing members shall meet the structural performance requirements specified in 1.07.

C. Metal framing shall be produced from the alloy specified in 2.01 and finished in accordance with the requirements of 2.04.

D. Provision shall be made in the glazing pocket of the framing for the following minimum clearances for the thickness and type of [glass] [and/or] [plastic sheet] shown on the schedule referred to in 2.07.A. The clearances shall be in accordance with the [FGMA Glazing Manual] [or] [manufacturer's recommendations] [or] [governing code requirements].

Minimum face clearance . . . (A) . . . mm (in)
Minimum edge clearance . . . (A) . . . mm (in)
Minimum bite (or edge cover) . . . (A) . . . mm (in)

(Architect select appropriate reference and specify requirements)

Refer to Glass, Table C, in the Technical Data Section of this Manual for minimum clearances for glass recommended by FGMA. Generally these clearances provide very satisfactory performance where glass is used. However, typical clearances given in Table C may vary by manufacturer, particularly for some special products or applications, in which cases the glass manufacturer's recommendations should be followed.

Designs suitable for glass are not necessarily suited for plastics, and for larger size plastic, the bite for plastic increases over what the bite for glass would be for the same pocket width. For plastics the recommendations of the manufacturer should be followed.

Glass must be edge blocked to prevent contact with metal framing.

E. Framing shall be designed to provide for glazing from the [inside] [or] [outside].

F. Framing shall accommodate [windows] [and] [doors] shown in the operable [window] [and] [door] schedule referred to in 2.09, panels referred to in 2.06, and other components shown in the . . . (A) . . . schedules.

G. Framing shall be designed so that panels can be removed from the [inside] [or] [outside] of the building.

H. Framing anchors shall provide for three-way adjustment to accommodate fabrication and construction tolerances. They shall be structurally adequate to carry the weight of the wall units, shall allow for thermal movement and shall meet the structural requirements as specified in 1.07. They shall be made from . . . (*specify metal and reference appropriate paragraph in 2.01*) . . . and shall have a protective finish of . . . (*specify protective material and refer to appropriate paragraph in 2.03*) . . .

I. Metal column covers shall be produced from . . . (*specify alloy and reference appropriate paragraph in 2.01*) . . . and finished in accordance with. . . (*refer to appropriate finish specification in 2.04*). . .

OR

Column covers shall be. . . (*specify requirements if different from above*). . .

J. . . . (*specify other components, metal and requirements*). . .

K. Flashings and other materials used internally or externally shall be corrosion resistant, non-staining, non-bleeding and compatible with adjoining materials.

In the use of metal flashings care should be taken that dissimilar metals do not come in contact. Refer to the commentary in 2.02. Copper flashing should not be used with aluminum. Even though the material may be insulated, the water runoff from copper may corrode the aluminum.

L. The installed curtain wall system shall meet the applicable performance requirements specified in 1.07.

2.06 PANELS

A. Supply panels in accordance with the schedule set forth in the Architect approved drawings. (*If stock panels are used include following*)

Panels shall be . . . (*identify*). . . manufactured by . . . (*name company*). . .

B. Panels shall meet the applicable performance requirements specified in 1.07.

C. Materials and Construction

If any of the panel constructions are to have insulation, sound deadening or other material applied in the shop, such material should be specified along with the panel construction. If insulation is to be installed in the field, it should be specified under 2.11.

1. Metal Facing Panels, Single Thickness

a. Flat sheet or plate panels shall be made [with backside stiffener members] [or] [with edge flanges], as shown on Architect's details.

b. Textured sheet panels shall be made [with backside stiffener members] [or] [with edge flanges].

c. Panels having impressed relief pattern or design shall be made as shown on architect's details but only after a full-size sample panel in . . . (*state material*) . . . has been submitted to and approved by the Architect.

d. Cast panels shall be made as shown on the Architect's details, but only after a full-size plaster model has been submitted to and approved by the Architect.

e. Panels comprised of formed metal sheets shall be made as shown on Architect's details. Sheets shall be formed as shown on details, using . . . (A) . . . thick metal and shall be [assembled in place by . . . (*state method*) . . .] [or] [assembled in the shop as detailed]. Joints between sheets shall be . . . (*indicate fastening and sealing methods*) . . .

f. Panels comprised of extruded shapes shall be made as shown on Architect's details. Shapes shall be extruded sections as detailed and shall be [assembled in place by . . . (*state method*) . . .] [or] [assembled in the shop as detailed]. Joints between shapes shall be . . . (*indicate fastening and sealing methods*) . . .

2. Adhesively Bonded Panels — Metal Faced

a. Panels metal faced one side shall be constructed as shown on Architect's details, using the specified materials:

Exterior skin
... (specify metal, finish and thickness)
Backing material
... (specify material, density, thickness, etc.)
Adhesive
... (specify brand and type)

The exterior skin shall be securely bonded to the backing to form a stable and durable composite unit.

b. Panels metal faced both sides shall be constructed as shown on Architect's details, using the specified materials:

Exterior skin
... (specify metal, finish and thickness)
Exterior skin backing
(if any): ... (specify material, density, thickness, etc.)
Core material
... (provide complete specification for material)
Interior skin backing
(if any): ... (specify material, density, thickness, etc.)
Interior skin
... (specify metal, finish and thickness)
Adhesive(s)
... (specify type(s) and brands(s))

Component materials shall be securely bonded together to form a stable and durable composite unit. Panels having cores of absorptive material shall have their edges sealed to prevent the entrance of water, but shall be so constructed as to provide a means of venting the core space to outside air.

3. Adhesively Bonded Panels — Glass Faced

a. Opaque panels with a reflective tempered glass or a heat strengthened or tempered glass with ceramic fired-on frit on the exterior side shall be constructed as shown on the Architect's details using the specified materials:

Exterior glass
... (specify glass type and thickness)
Opacifier (when needed)
... (specify material, or general requirements)
Adhesive
... (specify type)
Core material
... (specify k-value, thickness and density)
Backing material
... (specify type and thickness)

Component materials shall be securely bonded together to form a stable and durable composite unit.

4. Mechanically Assembled Panels

a. Hollow box-type insulated panels shall be constructed as shown on Architect's details, using the specified materials:

Exterior facing
... (specify metal, finish and thickness)
Insulation
... (specify material, thickness, type, k-value and reference specification or standard)
Interior facing
... (specify metal, finish and thickness)

Facings shall be securely joined at their edges by non-corrosive fastenings and shall be so designed that through metal thermal conductance is minimized and the entrance of water is prevented. Edges shall not be hermetically sealed, but shall provide a means of venting the interior space to outside air.

b. Industrial-type panels shall be constructed as shown on Architect's details, using the specified materials:

Exterior facing
... (specify metal, finish and thickness)
Insulation
... (specify material, thickness, type, k-value and reference specification or standard)
Interior facing
... (specify metal, finish and thickness)

5. Non-Metallic Panels

... (specify type such as masonry, tile, plastic, etc.) ...

D. Fabrication and workmanship for panels shall meet the requirements specified in 2.13

2.07 GLASS AND PLASTIC GLAZING MATERIALS

(Note: Include only if glass and glazing are part of this contract.)

A. Supply and install [glass] [and] [plastic] glazing materials in accordance with the schedule set forth in the Architect approved drawings.

B. [Glass] [and] [plastic sheet] shall meet the applicable performance requirements specified in 1.07.

C. Flat glass products listed in D and E below shall conform to the quality thickness and dimensional tolerances set forth in ASTM C 1036.

D. Flat transparent glass shall be of Glazing Select Quality (q3) and one of the following classes: (Architect to specify)

- Class 1 — Clear
- Class 2 — Tinted Heat-Absorbing and Light-Reducing
- Class 3 — Tinted, Light-Reducing

E. Flat patterned or wired glass shall be of Glazing Select Quality (q3) and one of the following classes: (*Architect to specify*)

- Class 1 — Translucent
- Class 2 — Tinted Heat-Absorbing and Light-Reducing
- Class 3 — Tinted, Light-Reducing

The following information about glass should be helpful. More complete data about the different types will be found in AAMA's Aluminum Curtain Wall Series, Volume 6, "Glass and Glazing," and Volume 12, "Structural Properties of Glass," and in the FGMA Glazing Manual, as well as the manufacturers' literature.

Flat Glass (*IP dimensions in parentheses*)

Clear

Glazing select quality in 3 mm (1/8 in), 5 mm (3/16 in), 6 mm (1/4 in), 8 mm (5/16 in), 10 mm (3/8 in), 12 mm (1/2 in), 15 mm (5/8 in) and 19 mm (3/4 in) thicknesses.

Heat-Absorbing

Glazing select quality in grey and bronze tint 5 mm (3/16 in), 6 mm (1/4 in), 8 mm (5/16 in), 10 mm (3/8 in) and 12 mm (1/2 in) thicknesses.

Glazing select quality in green tint 3 mm (1/8 in), 5 mm (3/16 in) and 6 mm (1/4 in) thicknesses.

Processed Glass

Insulating

Organic and silicone edge seal types typically made of two sheets of 3 mm (1/8 in), 5 mm (3/16 in), or 6 mm (1/4 in) glass with 6 mm (1/4 in) or 12 mm (1/2 in) air space giving overall nominal thicknesses ranging from 12 mm (1/2 in) to 25 mm (1 in). Other glass and air space thicknesses are available upon application.

Tempered

Available in thicknesses of 3 mm (1/8 in) to 19 mm (3/4 in).

Heat strengthened

Available in thicknesses of 6 mm (1/4 in), 8 mm (5/16 in) and 10 mm (3/8 in).

Laminated

Available in a wide range of thicknesses.

Reflective

Available in 3 mm (1/8 in) to 12 mm (1/2 in) thicknesses of clear and tinted glass with the coating typically on one

surface. Certain thicknesses available in insulating and laminated glass.

Ceramic colored

Heat strengthened glass designed primarily for exterior use. Available in large variety of colors and in thicknesses from 6 mm (1/4 in) to 10 mm (3/8 in).

Sandblasted or etched

Any glass whose surface has been altered by sandblasting, etching, chipping, grinding, etc. Either one or both surfaces may be so treated.

To ensure the predicted performance from most of the reflective coated glasses, factory finished edges should be specified. Edges must not be cut, seamed, or otherwise modified after fabrication. Field cutting of heat strengthened and fully tempered glasses cannot be done.

F. Insulating glass shall meet the requirements of ASTM E 774, Class . . . (A) . . ., when tested in accordance with ASTM E 773.

ASTM E 774, Standard Specification for Sealed Insulating Glass Units specifies three levels of performance, Class A, Class B and Class C. Class A must meet the most stringent requirements of ASTM E 773, Seal Durability Test. When exposed to the high humidity part of this test, Class A units must meet the specified performance requirements after 42 days exposure compared to 28 days for Class B units and 14 days for Class C units. Under the accelerated weather cycle test for exposure to low and high temperatures, ultraviolet radiation, and water spray, Class A units must perform after 252 cycles compared to 196 cycles for Class B units and 140 cycles for Class C units. Each cycle is 6 hours in duration.

The performance requirement for Class C units states that there shall be no frost or chemical dew point for the test unit when measured at -34°C (-30°F) after the humidity test and the accelerated weather cycle test when tested in accordance with ASTM E 546. For Class B and Class A the same requirement exists when test units are measured at -29°C (-20 °F).

The Architect should specify the class of insulating glass desired. For curtain walls Class A is recommended. Field testing to determine the frost or dew point of insulating glass in the vertical position is done in accordance with ASTM E 576.

To be assured that insulating glass units meet the requirements of ASTM E 774 standard the Architect may specify that the units be certified by the Insulating Glass Certification Council, IGCC. This Council, through independent laboratories, tests the product of manufacturers against the standard and certifies their compliance. A Certified Products Directory is available from IGCC.

G. Tempered, heat strengthened and ceramic colored or spandrel glass shall conform to ASTM C 1048.

Heat treatment strengthens glass and increases its resistance to breakage.

H. [Acrylic] [or] [polycarbonate] plastic sheet products listed below shall conform to the standards published by [. . . list manufacturer. . .] [or] [. . . other standards organization . . .].

In double glazed walls and windows, plastic sheet may be used in combination with glass. Such a combination will, in some situations, provide better resistance to sound transmission.

Plastics expand and contract with temperature changes a great deal more than glass and metal. As a result special consideration must be given to their glazing requirements, especially with regard to depth of rabbet. This information is available in the manufacturer's literature and in the FGMA Glazing Manual. The requirements for acrylics and polycarbonates are the same. Refer to the Technical Data Section of this manual for data on these two plastics.

The quality sealant systems — butyl tapes, silicones, polysulfides, and others — used with glass, may also be used with plastics. Plastic manufacturers' recommendations should be followed.

I. Safety glazing materials shall conform to [ANSI Z97.1] [or] [CPSC 16 CFR 1201] [or] [19GP-1c].*

To be assured that safety glazing materials meet the requirements of ANSI Z97.1 or CPSC 16 CFR 1201 the Architect may specify that the materials be certified by the Safety Glazing Certification Council (SGCC). This Council, through independent laboratories, tests the products of manufacturers against the standard and certifies their compliance. A certified products directory is available from SGCC.

* Canadian Government Specification

2.08 GLAZING SYSTEMS

A. Setting blocks used to support glass shall be an elastomeric material of 85 ± 5 Shore A durometer hardness. Blocks shall be placed in the positions shown on the Architect approved drawings and shall be of the size specified thereon.

Glass should always be set on two identical setting blocks of an elastomeric material or lead. Length of blocks of elastomeric material should be 25 mm/m^2 (0.1 in/ft^2) of glass area but never less than 6 mm (4 in). Length of blocks of lead should be 13 mm/m^2 (0.05 in/ft^2) of glass area but never less than 6 mm (4 in). Lead blocks should

not be used with insulating, laminated or wired glass, nor should they be used with glass less than 12 mm (1/2 in) thick. Setting blocks should be equidistant from the center of the glass preferably at quarter point locations. When it is necessary to move the blocks out from the preferred quarter point locations to avoid excessive deflection in the supporting member, or for other reasons, their outer edges must be no closer to the corners of the glass than 150 mm (6 in) or 1/8th of the glass width, whichever is greater.

B. Edge blocks used for centering the glass and preventing lateral “walking” shall be an elastomeric material of 65 ± 5 Shore A durometer hardness. Blocks shall be placed in the positions shown on the Architect approved drawings and shall be of the type and size specified thereon.

Edge blocks should be located at both jambs of the glass to prevent the edges of the glass from being nicked during installation and to prevent the glass from “walking” in the opening after installation. They should be a minimum of 100 mm (4 in) long, with a minimum of two per jamb located at the top and bottom edges of the glass. A nominal 3 mm (1/8 in) clearance between the blocks and the glass should be allowed. The Architect is referred to the FGMA Glazing Manual, to AAMA's “Aluminum Curtain Walls,” Volume 6, and to glass manufacturers' literature, for further information on this subject. Proper use of edge blocks is critical to the satisfactory performance of curtain walls.

C. Gaskets, Tapes and Wet Sealants with Spacers

All [glass] [and] [panels] shall be held in the proper plane and with the necessary face clearance by continuous glazing gaskets, tapes, or wet glazing with spacers, using materials as specified in 2.13. The glazing materials shall extend around the entire periphery and shall provide the specified resistance to air and water infiltration. Wet sealants shall be compatible with the materials they contact.

D. Blocks and spacers shall meet the requirements of ASTM C 864.

Reflective insulating glass has special requirements. Consult the glass manufacturer and follow his recommendations. Refer to AAMA-TIR-A4 on this subject.

2.09 WINDOWS AND DOORS

A. Operable [windows] [and] [doors] shall be furnished and installed in accordance with the schedule set forth in the Architect approved drawings.

B. Operable [windows] [and] [doors] shall meet the applicable performance requirements specified in 1.07.B.1, 1.07.C.2, 1.07.D.5 and 1.07.E.2.

C. Operable [aluminum windows] [and] [aluminum sliding doors], except to the extent that performance requirements may be at variance with the requirements of 2.09 B, shall conform to [ANSI/AAMA 101 or AAMA GS 001 for the window types specified] [and] [ANSI/AAMA 101 for sliding door types specified].

D. Operable steel windows shall conform to the current recommended specifications of the Steel Window Institute.

E. Operable [stainless steel] [bronze] [other metal] [windows] [and] [doors] shall conform to [. . . (*list manufacturer's or other specifications*) . . .].

F. Windows shall be designed for glazing from the [inside] [or] [outside].

G. Finishes on exposed metal parts of [windows] [and] [doors], excluding hardware, shall be the same as that specified for the curtain wall framing in [2.04] [or] [. . . (*specify other requirement*) . . .].

H. [Glass] [or] [plastic sheet] types shall be those shown on the schedule on the drawings and specified in 2.07.

I. Screens shall be framed in the same metal and finish as the [windows] [and] [doors] [or] [. . . (*specify other requirement*) . . .].

J. Screening

1. Metal screening shall conform to FS RR-W-365A.

2. Non-metal screening shall conform to ASTM D 3656.

K. Operating hardware for [windows] [and] [doors] [and] [screens] shall be compatible with the metal specified for the frames.

(Note: This paragraph is needed only if hardware requirements are not covered in 2.09.C, D or E.)

Paragraph 2.09 is necessary only for walls containing operable windows and/or doors. If all glass in the wall is fixed, this paragraph may be omitted since all components of fixed glazing are covered in other parts of the specifications. The doors specified in this paragraph are sliding doors or swing doors used for egress through the exterior wall to balcony areas or other areas. They are not the entrance doors which are used in the store front wall area.

Inclusion of the windows and doors in this section makes them a responsibility of the Wall Contractor. This better ensures their compatibility with the wall design and alleviates the problems of scheduling and divided responsibility.

2.10 OTHER PROPRIETARY WALL COMPONENTS

. . . (*name proprietary items*) . . . as manufactured by . . . (*name company*) . . . shall be furnished and installed in accordance with the schedule shown on the Architect approved drawings. These . . . (A) . . . shall be . . . (*give product type and identification*) . . .

2.11 FIELD INSTALLED INSULATING MATERIALS

A. Insulating materials shall be furnished and installed in accordance with the schedule set forth in the Architect approved drawings.

B. Insulating materials shall conform to the following specifications:

1. Cellular Glass

[FS HH-I-551E, Type [1] [or] [IV] [or] [ASTM C 552]

2. Mineral Fiber (*Including Glass Fiber*)

a. Flexible blanket and felt

[FS HH-I-521F, Type [I] [or] [II] [or] [III] [or] [FS HH-I-558B, Form B, Type I, Class [6] [or] [7] [or] [ASTM C 553] [or] [ASTM C 991]

b. Blocks and boards

[FS HH-I-558B, Form A, Class [1] [or] [2] [or] [AAMA SI-2-88] [or] [FS HH-1-526C]

3. Rigid Urethane Foam

[FS HH-I-530B, All Types & Classes (*select type and class required*)

4. Rigid Polystyrene Foam

a. Molded foam bead board

FS HH-I-524C, Type [I] [or] [II], Class A

b. Extruded foam board

FS HH-I-524C, Type II, Class B

5. Others

C. Insulating materials shall meet the requirements for fire resistance specified in 1.07.H (*Specify only when required*)

D. Installation materials and accessories: . . . (A) . . . (*specify items*) . . .

2.12 SEALING AND GLAZING MATERIALS

A. Sealing and glazing materials shall be furnished and installed in accordance with the schedule set forth in the Architect approved drawings.

Selection of the proper materials for these purposes is essential to good curtain wall design and satisfactory results depend upon a proper understanding of the relative merits and capabilities of the many materials available. Furthermore, it is important that sealants used in combination are compatible, and that materials and methods used for cleaning the wall are not injurious to sealing materials. For information on all of these matters, the specification writer is advised to consult AAMA's Aluminum Curtain Wall Series, Volume 6, "Joint Sealants in Aluminum Curtain Walls," FGMA Sealant Manual and sealant manufacturers.

B. Materials shall conform to the following specifications:

1. Acrylic compounds:

[FS TT-S-00230C(2)] [or] [19GP5b]* [or] [AAMA 803.3]

2. Butyl compounds:

a. skinning type

For non-staining [FS TT-S-001657] [or] [19GP-14]*

b. Non-skinning type

AAMA 809.2

3. Polyurethane compounds:

a. One-part compounds

[FS TT-S-00230C(2)] [or] [19GP-16a]*

b. Two-part compounds

[FS TT-S-00227E(3)] [or] [19GP-15a]*

4. Silicone compounds:

a. One-part compound

[FS TT-S-001543A] [or] [FS TT-S-00230C(2)] [or] [19GP-9b]* [or] [19GP-18]*

b. Two-part compounds

[FS TT-S-00227E(3)] [or] [19GP-19]*

5. Dry elastomeric gaskets

a. Cellular (closed cell)

ASTM C 509

b. Non-Cellular (dense)

ASTM C 864

6. Narrow joint seams sealer

AAMA 803.3

7. Preformed tape, non-curing type ductile back bedding glazing tape

AAMA 804.1

8. Bonding type back bedding glazing tape

AAMA 806.1

9. Cured rubber type glazing tape

AAMA 807.1

10. Exterior perimeter sealing compound

AAMA 808.3

11. Non-drying sealants

AAMA 809.2

12. Expanded cellular glazing tape

AAMA 810.1

13. Lockstrip gaskets, all types and materials

ASTM C 542

For information on lockstrip gaskets, refer to AAMA's Aluminum Curtain Wall Series, Volume 4, "Lockstrip Gaskets in Architectural Applications."

*Canadian Government Specifications

2.13 FABRICATION

A. General

All parts of the curtain wall system shall be of the materials, design, sizes and thicknesses, subject to commercial tolerances, shown or called for on the Architect approved drawings and/or herein specified. Methods of fabrication and assembly, however, unless otherwise specifically stated, shall be at the discretion of the manufacturer.

B. Joints in Metal Work

All exposed work shall be carefully matched to produce continuity of line and design, with all joints, unless otherwise shown or specified, being accurately fitted and rigidly secured.

C. Shop Assembly

As far as practicable, all fitting and assembly work shall be done in the shop.

D. Exposed Fasteners

Exposed fasteners on finished surfaces shall have . . . (*name type*) . . . screw heads unless otherwise shown or specified. Fasteners shall meet the requirements of 2.02.

E. Protection of Metals

Protection against galvanic action shall be provided wherever dissimilar metals are in contact, except in the case of aluminum in contact with galvanized steel, zinc, or relatively small areas of stainless steel or nickel silver (white bronze). This protection shall

be provided either by painting the contact surfaces with zinc chromate primer as specified in 2.03.A.4 or by application of an appropriate sealant or tape.

F. Welding

1. All welding shall be in accordance with recommendations of the American Welding Society and shall be done with electrodes and/or by methods recommended by the suppliers of the metals being welded. Type, size and spacing of welds shall be as shown on approved shop drawings.

2. Welds behind finished surfaces shall be so done as to minimize distortion and/or discoloration on the finished side. Weld spatter and welding oxides on finished surfaces shall be removed by descaling and/or grinding.

3. All glass surfaces should be protected from weld spatter.

Weld spatter can cause surface damage which can materially weaken the glass. Whenever possible, welds should be placed in concealed locations, to avoid the problems of color matching and the cost of laborious and critical finishing work. On welded aluminum which is anodized, there will usually be a visible variation of color at surface welds, even though they are ground and polished smooth. Welding lowers the allowable stress in aluminum alloys and this must be taken into account in the design.

G. Soldering and Brazing

All soldering and brazing shall be done as recommended by the suppliers of the metals involved.

H. Fabrication of Stainless Steel, Copper and Copper Alloys

1. Surfaces which have been subjected to severe forming operations or have been ground and polished shall be cleaned of all extraneous material, stainless steel shall be thoroughly rinsed with water and dried. Copper and copper alloys shall be cleaned with solvents.

2. Special care shall be taken to see that all tools used in fabricating, grinding and polishing stainless steel, copper and copper alloys are clean and free from particles of iron or iron compounds.

3. Soldering shall be employed only for filling or sealing of joints, and shall not be relied upon for mechanical strength. Immediately after soldering, all fluxes shall be

removed by washing with a strong neutralizing solution, followed by clear water rinse and drying in the case of steel and solvent rinse in the case of copper.

4. All lubricants used in fabrication shall be removed before the work leaves the shop.

I. Shop Painting of Steel

Items of steel, unless galvanized or scheduled for other finish in 2.04.C, shall be thoroughly cleaned of all loose scale, filings, dirt and other foreign matter, and shall be painted with. . . (A) . . .

J. Use of Sealing Materials

Sealing materials shall be used in accordance with the recommendations of the manufacturer of the material and joints to be sealed shall be in accordance with the designs and tolerances shown on the Architect approved shop drawings.

K. Shop Glazing

Glazing work shall be done in accordance with the recommendations of the [FGMA Glazing Manual] [or] [Glazing Materials Manufacturer].

For structural sealant glazing information, refer to AAMA's Aluminum Curtain Wall Series, Volume 13, "Structural Sealant Glazing Systems".

PART 3 — EXECUTION

3.01 LINES, ELEVATIONS AND PRIOR INSPECTION OF THE STRUCTURE

A. Offset Lines and Bench Marks

The General Contractor shall provide the Wall Contractor with a building perimeter offset line on each floor, plumb with lines on the floors below, and located at a point from the edge of the floor slab designated by the Wall Contractor. The General Contractor shall also provide clearly scribed bench marks on each floor on a column designated by the Wall Contractor. The General Contractor shall be responsible for the accuracy of the location of the perimeter offset lines and the elevations of the bench marks.

B. Prior Inspection

Before beginning installation in any assigned area, the Wall Contractor shall examine all parts of the structure affecting installation of his work in this area. Should any errors be found in the location of offset lines or bench marks, and should any condition be found in the structure which, in his opinion, will prevent proper execution of his work, he shall report such errors and conditions in writing to the General Contractor. Installation shall not proceed in the area until errors and unsatisfactory conditions have been corrected or adjusted to the satisfaction of the Wall Contractor.

C. Corrective Work

In the event that corrective work involves a delay in the installation schedule, such delay shall be handled in accordance with the provisions of the contract documents.

Proper location of building lines and elevations is critical to installation of a curtain wall and proper fitting with other building components. It also controls the esthetic appearance of the completed installation and assures adequate enframing of infill elements such as glass, spandrel panels, etc. Accurate control lines help assure that anchor sizing, expansion provisions and water infiltration control features will function as planned.

3.02 INSTALLATION

A. Curtain Wall Framing

[Curtain wall framing] [and/or] [preassembled framed units] shall be erected plumb and true, in proper alignment and relation to established lines and grades, as shown on the Architect approved shop and erection drawings.

B. Panels

Panels shall be installed plumb and true in proper alignment and relation to [the curtain wall framing] [or]

[the established lines and grades] as shown on the Architect approved drawings.

C. Column Covers

Column covers shall be installed plumb and true in proper alignment and relation to the established lines and grades as shown on the Architect approved drawings.

D. Windows and Doors

Operable [windows] [and] [doors] shall be securely anchored in place to a straight, plumb and level condition, without distortion, in accordance with the Architect approved drawings. Weather stripping contact and hardware movement shall be checked and final adjustment made for proper operation and performance of units.

(Note: This paragraph is required only if windows and doors are field installed.)

3.03 ERECTION TOLERANCES

Permissible dimensional tolerances in the building frame and other work adjacent to the wall are specified in Section . . . (A) . . . of these specifications as follows:

- Variation from plumb, faces of exterior columns and walls..... . . . (A) . . .
- Variation from levels shown on drawings, top and bottom surfaces of floor slabs and spandrel beams..... . . . (A) . . .
- Variation from location shown on drawings, outer faces of walls, framing members and floor slabs..... . . . (A) . . .

The curtain wall shall be designed to accommodate these tolerances. Provided irregularities do not exceed them, and clearances shown on approved shop drawings are maintained, all parts of the curtain wall, when completed, shall be within the following tolerances:

Maximum variation from plane or location shown on approved shop drawings: 3 mm per 3600 mm (1/8 in per 12 ft) of length or 12 mm (1/2 in) in any total length.

Maximum offset from true alignment between two identical members abutting end to end in line: 1.5 mm (1/16 in).

3.04 INSTALLATION WITHIN MASONRY OPENINGS

Where work is to be installed within masonry openings, no parts other than built-in anchor devices shall be put in place until masonry work is completed.

3.05 ANCHORAGE

Anchorage of the wall to the building structure shall be in accordance with the approved shop and erection drawings. Anchors shall meet the requirements of 2.05 H. After the wall is properly positioned all connections so designated on Architect approved drawings shall be rigidly fixed.

3.06 WELDING

Welds and adjacent metal areas shall be thoroughly cleaned and painted with . . . (A) . . . coat(s) or primer as specified in 2.03. Special care shall be taken to prevent fires and to protect glass and other finished surfaces from damage by weld spatter.

If spatter from welding operations strikes glass or finished metal surfaces, irreparable damage will likely result, and appropriate protection measures are therefore, mandatory.

3.07 USE OF SEALING MATERIALS

Sealing materials specified in 2.12.B shall be used in strict accordance with the manufacturer's printed instructions, and shall be applied only by mechanics specially trained or experienced in their use. Before applying sealant, all mortar, dirt, dust, moisture and other foreign matter shall be completely removed from surfaces it will contact. Adjoining surfaces shall be left with a clean and neat appearance. Sealing compounds shall be tooled to fill the joint and provide a smooth finished surface.

3.08 POSTPONEMENT OF COMPLETE ENCLOSURE

If so directed by the General Contractor, installation of the wall shall be postponed in . . . *(state specific location(s) or area(s) . . . until . . . (state when) . . .* so as to facilitate moving material into and out of the building during construction.

3.09 FIELD GLAZING (If part of this Section)

A. Glass and glazing materials shall conform to the specifications of 2.07 and shall be installed in accordance with the schedule set forth in the drawings.

B. Setting blocks and spacers shall be supplied and installed to conform to the requirements of 2.08.

C. Unless otherwise specified, glazing shall be done in accordance with the recommendations of the FGMA Glazing Manual.

D. Glazing of [acrylic] [or] [polycarbonate] plastic sheets shall be done in accordance with the recommendations of the materials manufacturer.

E. Tapes shall not be applied to either side of the glass to indicate that an opening has been glazed.

Glass areas covered with tape may weather somewhat differently than adjacent glass areas, causing a differential marking. This differential marking is most noticeable on tinted glasses. Application of tapes to glass should therefore be avoided.

3.10 FIELD-APPLIED INSULATION (If any)

. . . *(name type)* . . . insulation, as specified in 2.11.B shall be applied to . . . *(describe location)* . . . using . . . *(name materials)* . . . as specified in 2.11.D.

3.11 REMOVAL OF DEBRIS

All debris caused by or incidental to the installation work shall be promptly removed to a location on each floor of the job site designated by the General Contractor. The General Contractor shall be responsible for removal from the designated location.

3.12 PROTECTION AND CLEANING

The Wall Contractor shall remove from the installed work all mastic smears or other unsightly marks caused by his workmen, and shall be responsible for any damage to or disfigurement of the work caused at any time by his own men. Protection of the work against damage by other trades, as well as any cleaning other than this shall be the responsibility of the General Contractor.

Cleaning of the wall must be done with due regard to possible detriment or damage to sealants. Cleaning of parts prior to sealing must leave no oily residue to prevent proper sealant adhesion, and if cleaning is done after sealing, proper precautions must be taken to protect installed sealants from damage.

SECTION 2

TECHNICAL DATA

SPECIFICATION FOR PREFORMED FIBROUS GLASS INSULATION: AAMA SI-2-88

1.0 SCOPE

This specification applies to lightweight preformed fibrous glass materials for use as thermal insulation in exterior walls of buildings.

2.0 DESCRIPTION

2.1 The basic material shall be glass, processed from a molten state into fibrous form and bound together with a suitable binder to form a board or block-type product.

2.2 Finished edges of the material shall be square unless otherwise specified.

3.0 DETERMINATION OF DENSITY

The density shall be determined by weighing an entire bundle of the material and dividing the weight in kg (lbs) by the nominal volume in m³ (ft³). A tolerance of 10% shall be permissible.

4.0 PROPERTIES

4.1 Compressive Strength of the material, in kg/m² (psf), shall be determined in accordance with ASTM C 165-83. Minimum values at 10% deformation shall be as follows:

Density, kg/m ³ (lbs/ft ³)	40 (2.50)	52 (3.25)	68 (4.25)	96 (6.00)	124 (7.75)	144 (9.00)	168 (10.50)
Minimum compressive strength kg/m ² (psf)	375 (77)	488 (100)	732 (150)	1465 (300)	2026 (415)	2441 (500)	4394 (900)

4.2 Flame Resistance: The material as installed shall have a flame rating not higher than 25, with no evidence of continuous progressive combustion, and a smoke developed rating not higher than 50, when tested by ASTM E 84-87. No material which is subject to increase in flame spread rating or combustibility beyond these limits, due to the effects of age, moisture or other atmospheric conditions shall be acceptable.

4.3 Thermal Conductivity (k) of the material, expressed in W/(m•k) [(Btu•in)/(hr•ft²•°F)], when measured by the guarded hot plate method described in ASTM C 177-85, at a mean temperature of 24°C (75°F), shall not exceed the following values:

Density, kg/m ³ (lbs/ft ³)	40 (2.50)	52 (3.25)	68 (4.25)	96 (6.00)	124 (7.75)	144 (9.00)	168 (10.50)
k-value	0.03 (0.24)	0.04 (0.25)	0.04 (0.25)	0.04 (0.25)	0.04 (0.25)	0.04 (0.26)	0.04 (0.27)

4.4 Moisture Absorption shall not exceed 2% when tested in accordance with ASTM C 553-70 (1977).

5.0 ALKALINITY

The alkalinity of the material, expressed as equivalent sodium oxide (Na₂O), shall not exceed 0.80%, when tested as follows: Weigh a 5-gram (\pm 0.01 gram) representative sample of the material and place it in a 500 milliliter pyrex Erlenmeyer flask. Wet with 5 ml of 95% ethyl alcohol and add 400 ml of distilled water. Reflux for four (4) hours \pm five (5) minutes. Then disconnect the condenser and filter at once through No. 41 Whatman paper supported in a Buchners funnel. Wash the flask and material three times with 25 ml portions of hot distilled water, using suction. Titrate immediately with 0.02 H₂SO₄, using six to eight drops of 1% solution of phenol-red indicator, to the disappearance of the pink color. Run

a blank determination on the same amount of distilled water and alcohol and correct for any alkalinity shown. The percentage alkalinity as Na₂O₁, shall be calculated by the formula:

$$\text{percent Na}_2\text{O} = 0.0124 (\text{mis. H}_2\text{SO}_4, \text{ used by blank})$$

6.0 ACIDITY

The material shall show no trace of sulphur when tested by the boiling water method, and shall not accelerate corrosion on steel, copper or aluminum, when tested by the procedure given in U.S. Maritime Specification 32-MC-1.

GENERAL

THERMAL EXPANSION OF BUILDING MATERIALS			
In temperature range of from 20 to 100°C (68 to 212°F) unless otherwise noted.			
<i>Material</i>	<i>mm/(mm•°C)</i> <i>[in/(in•°F)] (x10⁻⁶)</i>	<i>mm in one meter (inches in ten feet)</i> <i>for a temperature rise of:</i>	
		<i>38°C (100°F)</i>	<i>66°C (150°F)</i>
Wood: perpendicular to grain	0.3 to 0.6 (1.9 to 3.2)	0.58 to 0.99 (0.023 to 0.039)	0.86 to 1.47 (0.034 to 0.058)
parallel to grain	0.4 to 0.7 (2.1 to 3.6)	0.64 to 1.09 (0.025 to 0.043)	0.97 to 1.65 (0.038 to 0.065)
Brick masonry	0.6 (3.1)	0.94 (0.037)	1.42 (0.056)
Limestone masonry	0.6 (3.5)	1.07 (0.042)	1.60 (0.063)
Cellular glass	0.7 (4.0)	1.22 (0.048)	1.83 (0.072)
Float glass	0.9 (5.1)	1.55 (0.061)	2.34 (0.092)
Stainless steel, Type 430	1.1 (5.8)	1.78 (0.070)	2.64 (0.104)
Concrete	1.2 (6.5)	1.98 (0.078)	2.97 (0.117)
Structural steel	1.2 (6.7)	2.03 (0.080)	3.07 (0.121)
Plaster	1.7 (9.2)	2.79 (0.110)	4.22 (0.166)
Copper, 110	1.7 (9.4)	2.87 (0.113)	4.29 (0.169)
Stainless steel, Type 302/304	1.7 (9.6)	2.92 (0.115)	4.39 (0.173)
Red brass, 230	1.8 (10.0)	3.05 (0.120)	4.57 (0.180)
Architectural Bronze, 385	2.0 (11.0)	3.35 (0.132)	5.03 (0.198)
Muntz metal, 280	2.0 (11.0)	3.35 (0.132)	5.03 (0.198)
Aluminum	2.3 (12.9)	3.94 (0.155)	5.89 (0.232)
Lead	2.9 (15.9)	4.83 (0.190)	7.26 (0.286)
Zinc, rolled	3.1 (17.3)	5.28 (0.208)	7.90 (0.311)
Plastics: Phenolics	1.5 to 4.5 (8.5 to 25)	2.59 to 7.62 (0.102 to 0.300)	3.89 to 11.43 (0.153 to 0.450)
Glass-reinforced polyesters	1.8 to 2.5 (10 to 14)	3.05 to 4.27 (0.120 to 0.168)	4.57 to 6.40 (0.180 to 0.252)
Acrylics	7.5 (41.0)	12.50 (0.492)	18.75 (0.738)
Polycarbonates (unfilled)	6.8 (37.5)	11.43 (0.450)	17.15 (0.675)
Rigid polyvinyl chloride (PVC)	40.0 to 80.0 (22.0 to 44.0)	6.71 to 13.41 (0.264 to 0.528)	10.06 to 20.13 (0.396 to 0.792)

SPECIFIC HEAT, DENSITY AND THERMAL CONDUCTIVITY OF BUILDING MATERIALS				
<i>Construction Materials</i>	<i>Specific Heat BTU/(lb•°F)[J/(kg•K)]</i>	<i>Density kg/m² (lbs/ft³)</i>	<i>Thermal Conductivity W/(m²•K) [BTU/(hr•ft²•°F)]</i>	
			<i>per meter (foot)</i>	<i>per mm (in)</i>
Aluminum (1100)	896 (0.214)	2707 (169)	221 (128)	221,000 (1,536)
Brick, building	837 (0.2)	1970 (123)	0.69 (0.4)	690 (4.8)
Brass, red	377 (0.09)	8778 (548)	151 (87.0)	151,000 (1,044)
Brass, yellow	377 (0.09)	8314 (519)	119 (69.0)	119,000 (828)
Bronze	435 (0.104)	8490 (530)	29 (17.0)	29,000 (204)
Cement	670 (0.16)	1922 (120)	0.03 (0.017)	30 (0.2)
Concrete (stone)	653 (0.156)	2307 (144)	0.93 (0.54)	930 (6.5)
Copper (electrolytic)	385 (0.092)	8906 (556)	393 (227.0)	393,000 (2,724)
Gypsum	1084 (0.259)	1249 (78)	0.43 (0.25)	430 (3.0)
Marble	879 (0.21)	2595 (162)	2.60 (1.5)	2,600 (18)
Rigid polyvinyl chloride (PVC)		1442 (90)	0.15 (0.085)	50 (1.02)
Stainless Steel 302/304	502 (0.12)	8025 (501)	16 (9.4)	16,000 (113)
Stainless Steel 430	461 (0.11)	7753 (484)	26 (15.1)	26,000 (181)
Steel (mild)	502 (0.12)	7833 (489)	45 (26.2)	45,000 (314)
Wood, hard	1884-2721 (0.45-0.65)	368-1121 (23-70)	0.11-0.26 (0.065-0.148)	110-260 (0.78-1.78)
Wood, soft	2721 (0.65)	432 (27)	0.12 (0.068)	120 (0.82)
<i>Insulating Materials</i>				
Cellular glass	1005 (0.24)	144 (9)	0.06 (0.033)	60 (0.40)
Glass fiber board	795 (0.19)	64-144 (4-9)	0.04 (0.021)	40 (0.25)
Expanded polystyrene (extruded, plain)	1214 (0.29)	29 (1.8)	0.04 (0.021)	40 (0.25)
Expanded polystyrene (molded beads)	1214 (0.29)	16 (1.0)	0.04 (0.023)	40 (0.28)
Expanded polyurethane	1591 (0.38)	24 (1.5)	0.02 (0.013)	20 (0.16)
Mineral fiber board	712 (0.17)	24 (15)	0.04 (0.024)	40 (0.29)
<i>Glazing Materials</i>				
Acrylic	1465 (0.35)	1169 (73)	0.17 (0.100)	170 (1.20)
Glass	879 (0.21)	2531 (158)	0.93 (0.54)	930 (6.48)
Polycarbonate (unfilled)	1256 (0.30)	1185 (74)	0.20 (0.113)	200 (1.36)

TABLE A: TYPICAL THERMAL AND OPTICAL PROPERTIES OF HEAT-ABSORBING AND REFLECTIVE GLASS

Type of Glass	Thickness mm (in)	Daylight Transmittance (%)	Total Solar Transmittance (%)
<i>Heat-Absorbing^a</i> Grey	3 (1/8)	61	63
	4.8 (3/16)	51	53
	6 (1/4)	44	46
	8 (5/16)	35	38
	9.5 (3/8)	28	31
	12 (1/2)	19	22
Bronze	3 (1/8)	68	65
	4.8 (3/16)	59	55
	6 (1/4)	52	49
	8 (5/16)	44	40
	9.5 (3/8)	38	34
	12 (1/2)	28	24
Green-Tinted	3 (1/8)	83	63
	4.8 (3/16)	79	55
	6 (1/4)	75	50
Grey Insulating	25 (1)	39	35
Bronze Insulating	25 (1)	46	38
Green-Tinted Insulating	25 (1)	66	36
<i>Reflective (Coated):</i>			
	6 (1/4)	8-50	9-40
Heat-Absorbing			
Insulating	25 (1 ^b)	7-45	7-35

^a Transmittance values of heat-absorbing glass vary slightly from one producer to another. Also, values are subject to manufacturing tolerances stated in ASTM C 1036.

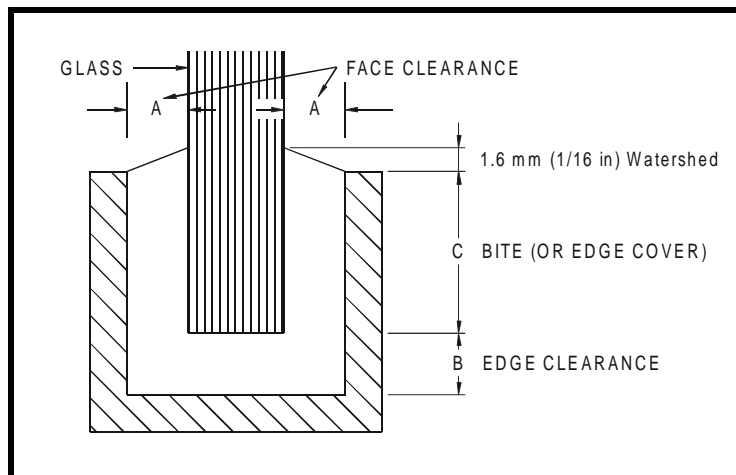
^b Total unit thickness. Outer glass is 6 mm (1/4 in) thick and of type listed; inner glass is clear 6 mm (1/4 in) float.

Heat-Absorbing Glass. This is float or sheet glass which has an admixture included in the glass batch to impart color and heat-absorbing characteristics to the glass. Gray and bronze tints are produced in thicknesses up to 12 mm (1/2 in) and green tints up to 6 mm (1/4 in). Table A lists the colors and thicknesses available from most producers.

TABLE B: REDUCTION IN LOUDNESS OF VARIOUS TYPES OF GLASS AND GLASS-AIR SPACE COMBINATIONS

A: Single Glass					
Glass Thickness mm (in)	Average Sound Transmission Loss (db) 125-4000 cps		% Loudness Reduction Compared to 6 mm (1/4 in) Float Glass		Nominal STC Rating
6 (1/4)	26.5		-		29
8 (5/16)	28.8		15		29
9.5 (3/8)	29.7		20		30
12 (1/2)	31.5		29		33
16 (5/8)	34.5		42		30
19 (3/4)	34.6		43		33
22 (7/8)	35.4		46		32
B: Laminated Glass (all with 1.1 mm (0.045 in) plastic interlayer)					
Glass Thickness mm (in)	Construction	Average Sound Transmission Loss (db) 125-4000 cps		% Loudness Reduction Compared to 6 mm (1/4 in) Float Glass	Nominal STC Rating
6 (1/4)	2 plies 3 mm (1/8 in)	30.2		23	33
12 (1/2)	2 plies 6 mm (1/4 in)	33.6		39	36
	1 ply 9.5 mm (3/8 in)				
12 (1/2)	1 ply 3 mm (1/8 in)	35.7		47	36
16 (5/8)	4 plies 3 mm (1/8 in)	36.3		49	38
19 (3/4)	2 plies 9.5 mm (3/8 in)	38.9		58	38
19 (3/4)	3 plies 6 mm (1/4 in)	38.7		57	39
25 (1)	6 plies 3 mm (1/8 in)	39.8		60	41
C: Glass Air Space Combinations					
Outer Glass Thickness mm (in)	Air Space Thickness mm (in)	Inner Glass Thickness mm (in)	Average Sound Transmission Loss (db) 125-4000 cps	% Loudness Reduction Compared To 6 mm (1/4 in) Float Glass	Nominal STC Rating
12 (1/2)	50 (2)	6 (1/4)	38.1	55	39
12 (1/2)	100 (4)	6 (1/4)	39.3	59	40
12 (1/2)	150 (6)	6 (1/4)	40.0	61	42
19 (3/4)	150 (6)	9.5 (3/8)	40.6	62	40
12 (1/2)	150 (6)	6 (1/4) laminated	42.6	67	44
8 (5/16)	100 (4)	4.8 (3/16)	37.4	53	39
As a guideline to the relative merits of various glasses and glass-and-air space combinations, the Sound Transmission Loss produced by a wide variety of glass types, as well as their Loudness Reduction compared with 6 mm (1/4 in) plate glass, are listed in Table B. Also listed are Sound Transmission Class (STC) Values. The STC Rating is an indication of the effectiveness of the various glasses in reducing the transmission of speech, radio, hi-fi and similar sounds in the broad speech range. The values are most directly usable for interior glass applications.					
The proper solution of building acoustical problems requires the consideration of interior masking noises, the building use, frequency of occurrence and intensity of intrusive noises, in addition to the sound reduction provided by the building walls. The values in Table B should be considered only as guidelines and the final choice of glass and glazing details should be made only after consultation with a qualified acoustician.					

GLASS



Glazed openings in curtain walls commonly have removable stops on only one or two sides of the opening, with fixed glazing channels on the other sides. When two opposite channels are fixed, one is usually deep and the other shallow, to provide for “slip glazing”. The deeper channel should have a minimum depth equal to 1) twice the nominal bite on the glass (see Table C), plus 2) the plus dimensional tolerance on the glass (see Table D), plus 3) the minus dimensional tolerance on the frame, plus 4) a minimum of 3 mm (1/8 in). Thus, if the bite, or edge cover on the glass, when installed, is to be 12 mm (1/2 in), the plus glass tolerance is 4.8 mm (3/16 in), and the minus frame tolerance is, say, 1.6 mm (1/16 in) the minimum depth of the deeper channel should be 2 mm x 12 mm + 4.8 mm + 4.8 mm + 3 mm = 36.6 mm (2 x 1/2 in + 3/16 in + 3/16 in + 1/16 in = 1 3/8 in). The depth of the shallower channel should be not less than the nominal glass bite plus the required edge clearance. Tables C and D list the applicable dimensions for various types and thicknesses of glass.

TABLE C: RECOMMENDED FACE AND EDGE CLEARANCES AND BITE (OR EDGE COVER)

Thickness		Minimum Clearance		
mm	(in)	A = Face	B = Edge	C = Bite
Monolithic Glass				
2.5	(S.S.)	1.5 (1/16)	3 (1/8)	6 (1/4)
3	(1/8 – D.S. ¹)	3 (1/8)	3 (1/8)	6 (1/4)
3	(1/8 – D.S. ²)	3 (1/8)	6 (1/4)	10 (3/8)
5	(3/16 ¹)	3 (1/8)	5 (3/16)	8 (5/16)
5	(3/16 ²)	3 (1/8)	6 (1/4)	10 (3/8)
6	(1/4)	3 (1/8)	6 (1/4)	10 (3/8)
8	(5/16)	5 (3/16)	8 (5/16)	11 (7/16)
10	(3/8)	5 (3/16)	8 (5/16)	11 (7/16)
12	(1/2)	6 (1/4)	10 (3/8)	11 (7/16)
15	(5/8)	6 (1/4)	10 (3/8)	12 (1/2)
19	(3/4)	6 (1/4)	12 (1/2)	15 (5/8)
22	(7/8)	6 (1/4)	12 (1/2)	19 (3/4)
Insulating Glass				
12	(1/2)	3 (1/8)	3 (1/8)	12 (1/2)
15	(5/8)	3 (1/8)	3 (1/8)	12 (1/2)
19	(3/4)	5 (3/16)	6 (1/4)	12 (1/2)
25	(1)	5 (3/16)	6 (1/4)	12 (1/2)
Ceramic Coated Spandrel Glass				
6	(1/4)	5 (3/16)	6 (1/4)	12 (1/2)

¹ Annealed Glass only.

² Tempered Glass only.

NOTE: Typical clearances above may vary by manufacturer, particularly for some special products or applications. Follow the recommendations of the glass manufacturer, fabricator or sealant supplier for individual instances. For pocket glazing in fixed channel, an increase of these dimensions is often advisable to facilitate installation.

TABLE D: LENGTH AND WIDTH TOLERANCES FOR GLASS

<i>Type of Glass</i>	Thickness mm (in)	Tolerance mm (in)
Single Float	3 to 6 (1/8 to 1/4)	±1.5 (±1/16)
	8 (5/16)	±0.8 (±3/32)
	10 (3/8)	±0.8 (±3/32)
	12 (1/2)	±3.0 (±1/8)
	15 (5/8)	±4.5 (±5/32)
	19 (3/4)	±5.0 (±3/16)
	22 (7/8)	±5.6 (±7/32)
Heat-Strengthened and Fully Tempered Spandrel Glass with Fired-On Frit	3 to 6 (1/8 to 1/4)	±1.5 (±1/16)
	6 to 10 (1/4 to 3/8)	±0.8 (±3/32)
	10 to 12 (3/8 to 1/2)	±3.0 (±1/8)
Insulating Glass Units	All Sizes	+5.0, -1.5 (+3/16, -1/16)

TABLE E: SHADING COEFFICIENTS

<i>Glass Type</i>	No Shading	With Shading Device	
Single Clear Glass			
	3 mm (1/8 in)	0.55-0.70	
6 to 12 mm (1/4 to 1/2 in)	0.95	0.55-0.70	
Heat-Absorbing Glass (Gray, Bronze, Green-Tinted)			
	6 mm (1/4 in)	0.70	0.45-0.53
	10 mm (3/8 in)	0.56	0.40-0.47
	12 mm (1/2 in)	0.50	0.37-0.40
Single Reflective Coated Glass (Range of Shading Coefficients: 0.25-0.60)			
		0.25	0.19-0.21
		0.30	0.23-0.24
		0.40	0.30-0.33
		0.50	0.38-0.42
	0.60	0.43-0.50	
Clear Insulating Glass	0.83	0.48-0.58	
Heat-Absorbing Insulating Glass (Range of Shading Coefficients: 0.17-0.50)			
		0.56	0.39-0.45
		0.17	0.14-0.16
		0.20	0.17-0.18
		0.30	0.26-0.27
	0.40	0.32-0.37	
	0.50	0.40-0.45	

Table E lists Shading Coefficients for most glass types without shading devices, as well as the range of Shading Coefficients possible with normally available shading devices such as Venetian blinds or draperies. Note particularly that, for most glass, a shading device can produce significant reductions in the Shading Coefficient. With reflective coated insulating glass, however, the reductions are small, since the high efficiency of this glass allows very little solar heat to pass through to be influenced by the shading device.

PLASTICS

ACRYLIC AND POLYCARBONATE SHEET

Most acrylic and polycarbonate sheets are classed as safety glazing materials as defined by ANSI-Z97.1 and CPSC 16 CFR 1201.

Plastic sheets are subject to greater dimensional change due to thermal expansion and contraction than most other materials with which they are commonly used in construction. The following table compares this characteristic.

	<i>mm/mm/°C (in/in/°F)</i>
Acrylics	0.0000750 (0.0000410)
Polycarbonates	0.0000680 (0.0000375)
Aluminum	0.0000230 (0.0000129)
Stainless Steel 302/304	0.0000017 (0.0000096)
Structural Steel	0.0000012 (0.0000067)
Float Glass	0.0000009 (0.0000051)

The glazing characteristics of these plastics are substantially different from those of glass. Particular attention must be paid to thermal movements, adhesion and compatibility with glazing materials and preparation of the glazing rabbet. Plastic sheets must be installed in systems that are designed to accommodate their characteristics. Plastic sheet manufacturers should be contacted for recommendations developed by them on the use of their materials in glazing applications.

It is permissible to set the sheets directly on the bottom of the sill but, with pressure equalization and weep systems, it may be necessary to use setting blocks to prevent blockage of weep holes.

The sheets should be cleaned with mild household cleaning agents such as soaps, detergents and ammonia. Most organic solvents, with the exception of VM & P naphtha and alcohol, will attack the plastics and therefore should not be used.

Since standard plastic sheets are vulnerable to scratching, special care must be taken to avoid damage during cleaning.

Both acrylic and polycarbonate sheets are available with applied transparent coatings which improve the scratch resistance of the surfaces. Improved UV resistance is also available in many sheet products.

Polycarbonate sheets are available in double or triple walled extruded panels. These provide superior insulating properties compared to single layer panels.

Plastic sheets should not be used for sealed insulating units because their relatively high vapor transmission rate allows excessive moisture to enter the air space.

A difference between temperature and/or humidity conditions prevailing on opposite sides of a sheet may cause the sheet to bow slightly towards the surface exposed to the higher temperature and/or humidity. However, the sheet will return towards its original condition as soon as the temperature or humidity differential has been reduced.

Plastic sheets are normally protected by masking on both surfaces when received. If left on for too long or under adverse storage conditions, the masking may be difficult to remove. It is recommended, where conditions permit, that plastic sheets be unmasked just prior to installation, immediately after any job site cutting-to-size. The manufacturer can provide advice on this matter.

Because of its high impact resistance, polycarbonate sheet is well suited for installations where protection against vandalism and burglary is important. A 6 mm (1/4 in) polycarbonate sheet has 270 J (200 ft-lbf) impact resistance compared to 9.5 J (7 ft-lbf) for 6 mm (1/4 in) acrylic sheet and 4.1 J (3 ft-lbf) for 6 mm (1/4 in) tempered glass.

Manufacturers of plastic sheets offer a wide variety of products and can provide whatever technical data is needed by the specifier to make a proper product selection.

METALS

GUIDE FOR THE SELECTION OF ALUMINUM ALLOYS

Sheet and Plate:

For typical applications such as panels, fascias, column covers, sunshades, ductwork, gutters, flashings, etc.:

General purpose non-heat-treatable alloys:

3003

Most widely used general-purpose sheet alloy. Economical for sheets having fair mechanical properties and excellent formability. Takes on a slight brownish yellow cast when anodized, and is susceptible to structural streaking that is particularly noticeable in large flat areas.

5052

Slightly better mechanical properties and higher cost than Alloy 3003. Good workability and excellent corrosion resistance, even in salt air exposures. Excellent weldability. Assumes yellowish cast when anodized, and is susceptible to structural streaking, particularly in large flat areas.

Non-heat-treatable alloys suitable for anodizing:

1100

Low strength alloy, appropriate for applications requiring high degree of formability. Finishes well.

1135

Somewhat higher purity than Alloy 1100, and gives a brighter finish. Mechanical properties are similar to those of Alloy 1100.

5005

Commonly used for low-cost all-purpose sheets having good formability and finishing characteristics. Slightly better mechanical properties than Alloy 1100. Good anodized appearance match with 6063 extrusions.

For proprietary alloys designed for quality applications where excellent anodized appearance is critical, consult the aluminum producers.

Heat-treatable Alloys:

6061

Most economical and versatile of the heat-treatable alloys. Used chiefly for roll-formed structural shapes and other applications requiring high strength. Good anodized appearance match with 6061 and 6105 extrusions, but not with 6063 extrusions. May take on yellowish cast when clear anodized.

General Note Regarding Clad Alloys:

Improved finishing characteristics may be obtained by cladding aluminum alloys with a thin layer of aluminum that is metallurgically bonded to a core alloy. The cladding may be of the same or different alloy than the core.

Caution: When buffing clad products, care must be exercised not to wear through the cladding. Clad products to be anodized should not be ground.

For Roofing and Siding:

Alclad 3004

Used for standard corrugated, ribbed and V-beam industrial roofing and curtain wall sheets. Not generally anodized.

Extrusions:

For typical applications such as mullions, sash, fascias, copings, thresholds, handrails, trim, etc.:

6063

Most commonly used extrusion alloy. Good anodized appearance match with Alloys 1100, 5005 and proprietary natural anodizing sheets.

6061

Used for extrusions requiring high strength. See listing under "Sheet and Plate" for general characteristics.

6105

Used for extrusions requiring high strength. Properties similar to 6061.

For proprietary alloys designed for quality applications where excellent anodized appearance is critical, consult the aluminum producers.

Fasteners: *(All fasteners except nails may be either plain or anodized)*

1100

Used for low-strength rivets and for washers.

2024

Used for bolts and screws.

5056

Used for nails.

6053

Used for medium-strength rivets.

6061

Used for nails and high-strength rivets, bolts, screws and washers.

6262

Used for nuts.

APPEARANCE MATCHING OF CLEAR ANODIZED ALUMINUM ALLOYS*							
(Alloys having same preparatory and Class I anodizing treatment)							
Form:	Sheet and Plate			Extrusions			Castings
Alloy:	1100	3003	5005	6061	6105	6063	F214
Match With Alloy							
1100	Good	Poor	Good	Poor	Poor	Good	Good
3003	Poor	Good	Poor	Fair	Fair	Poor	Poor
5005	Good	Poor	Good	Poor	Poor	Good	Good
6061	Poor	Fair	Poor	Good	Good	Poor	Poor
6105	Poor	Fair	Poor	Good	Good	Poor	Poor
6063	Good	Poor	Good	Poor	Poor	Good	Good

*For color matching of anodized proprietary alloys, consult the metal producer.

NOTE: It is important to recognize that color uniformity is not always obtainable, even with items of the same alloy. Matches indicated as "Good" in the above table, even though the best obtainable, should not necessarily be assumed to be consistently excellent.

GUIDE FOR CHOICE OF ALUMINUM FILLER ALLOYS

<i>Parent Alloys*</i>	<i>Filler Alloys</i>	<i>1100</i>	<i>3003</i>	<i>Alclad 3003</i>	<i>3004</i>	<i>Alclad 3004</i>	<i>5005</i>	<i>5052</i>	<i>6063†</i>	<i>6061†</i>
		<i>WSM</i>	<i>WSM</i>	<i>WSM</i>	<i>WSM</i>	<i>WSM</i>	<i>WSM</i>	<i>WSM</i>	<i>WSM</i>	<i>WSM</i>
6061†	4043	AA	AB	AB	AC	AC	AB	AC	AB	AC
	5254							CCA	CBB	CCB
	5554							CCB	CBA	CCB
	5356	BAA	BAA	BAA	BBA	BBA	BAA	BBA	BAA	BBA
	5556	BAA	BAA	BAA	BAA	BAA	BAA	BAB	BAA	BAB
6063†	4043	AA	AB	AB	AC	AC	AB	AB	AB	
	5254							CBB	CBB	
	5554							CBA	CBA	
	5356	BAA	BAA	BAA	BBA	BBA	BAA	BAA	BAA	BAA
	5556	BAA	BAA	BAA	BAA	BAA	BAA	BAA	BAA	BAA
5052	4043		AB	AB	AC	AC	AB	AC		
	5254							BCA		
	5554							CCB		
	5356		BAA	BAA	BBA	BBA	BAA	ABA		
	5556		BAA	BAA	BAA	BAA	BAA	AAB		
	5652							CCA		
5005	1100	BBA	BCA	BCA			CA			
	4043	AA	AB	AB	AB	AB	AB			
	5356	BAB	BAB	BAB	BAA	BAA	BAB			
	5556	BAB	BAB	BAB	BAA	BAA	BAB			
Alclad 3004	1100	CBA								
	4043	AA	AB	AB	AC	AC				
	5254				CCB	CCB				
	5554				CCA	CCA				
	5356	BAB	BAA	BAA	BBA	BBA				
	5556	BAB	BAA	BAA	BAA	BAA				
3004	1100	CBA								
	4043	AA	AB	AB	AC					
	5254				CCB					
	5554				CCA					
	5356	BAB	BAA	BAA	BBA					
	5556	BAB	BAA	BAA	BAA					
Alclad 3003	1100	ABA	ACA	ACA						
	4043	AA	AB	AB						
	5356	BAB	BAB	BAB						
	5556	BAB	BAB	BAB						
3003	1100	ABA	ACA							
	4043	AA	AB							
	5356	BAB	BAB							
	5556	BAB	BAB							
1100	1100	BBA								
	4043	AA								
	5356	CAB								
	5556	CAB								

Filler alloys are rated on the following characteristics:

SYMBOL	CHARACTERISTICS
W	Ease of welding
S	Strength of welded joint (in "as welded" condition). This rating applies particularly to fillet welds; all filler alloys rated will develop presently specified minimum strengths in butt welds.
M	Color matching after anodizing

A, B and C are relative ratings in decreasing order of merit. The ratings have relative meaning only within a given group. Combinations having no ratings are not recommended.

Filler alloy 5154 may be used in place of alloy 5254.

*For proprietary alloys, consult the metal producer.
 †Rating does not apply to these alloys when heat-treated after welding.

METALS

GUIDE FOR THE SELECTION OF COPPER ALLOYS

Historically, bronze has been defined as an alloy in which the chief constituents are copper and tin, and brass as an alloy in which the chief constituents are copper and zinc. Based on this definition, only the present architectural casting alloy could, by stretching a point, be classified as a bronze since it does contain from 2.0 to 3.0% tin. The other principal copper alloys in common architectural use would be true brasses, as they contain no tin.

The justification for designating these alloys as "bronzes" stems from the fact that, with the exception of copper and the nickel silvers, they resemble tin bronze in color, both in the natural finish and in the weathered state. Thus the alloys 230 (Red Brass), 280 (Muntz Metal), and 385 (Extruded Architectural Bronze) together with the casting alloy are referred to generally by architects and fabricators as "Architectural Bronze." In the natural finish they may simply be called "Yellow Bronze," in the intermediate weathered state "Statuary Bronze" and in the final weathered (patinated) state, "Green Bronze." Similarly the nickel silver alloys are often referred to as "White Bronze."

Although the adoption of a numerical designation system of copper alloys approved by the industry in 1961 has simplified classification, it is doubtful that the use of the word "bronze" to identify the principal copper alloys used in architectural work will ever be superseded.

Strip, Sheet and Plate

For roofing, siding, fascias, gutters, flashings, sunshades, ductwork, etc.:

Alloy 110 (Copper)

Most economical alloy, both in narrow strip and wide sheet. Fair mechanical properties and excellent formability. Can be readily soldered and brazed, but does not lend itself to welding. Natural color — salmon red.

Alloy 230 (Red Brass)

Better mechanical properties than alloy 110 with excellent formability. Can be readily soldered and brazed, but welding characteristics are only fair to poor. Natural color — reddish yellow.

For curtain wall panels, column covers, entrance frames, etc:

Alloy 110 (Copper)

Finds restricted use, because of limited color harmony with other alloys. An economical alloy in wide sheets. (See general characteristics above.)

Alloy 230 (Red Brass)

Problems of color match when weathered discourage use in combination with alloy 280 and extrusion alloy 385 for exterior applications.

(See above for general characteristics.)

Alloy 280 (Muntz Metal)

Sheet and plate alloy having good color match with extrusion alloy 385. Fair to good mechanical properties, but only fair formability. Readily soldered and brazed; fair to poor weldability. Natural color — reddish yellow.

Alloy 655 (High Silicon Bronze A)

Good mechanical properties and excellent formability. Applications limited because of poor color match with other alloys. Can be soldered, brazed and welded with good results. Natural color — reddish old gold.

Alloy 260 (Cartridge Brass, 70%)

An economical alloy in sheet form, but limited in architectural applications by lack of color match with other alloys. Used chiefly for lighting fixtures and interior trim items. Good mechanical properties and excellent formability. Readily soldered and brazed, and has fair to good welding qualities. Natural color — yellow.

Alloy 745 (Nickel Silver 65-10)

Relatively high cost alloy, particularly in sheet widths exceeding 610 mm (24 in). A "white metal" in the copper alloy series with good mechanical properties and excellent formability. Acceptable color match with extruded alloy 796 (Leaded Nickel Silver 10%.) Readily soldered and brazed, fair to good welding qualities. Natural color — warm silver.

Extrusions

For mullions, sash, doors and frames, handrails, trim, thresholds, etc.:

Alloy 385 (Architectural Bronze)

Principal extrusion alloy produced for architectural applications. Fair mechanical properties. Excellent hot forming, but poor cold forming characteristics. Can be readily joined by soldering and brazing, but welding characteristics are poor. Natural color — reddish yellow.

Alloy 796 (Leaded Nickel Silver 10%)

Nominal composition: Copper 45.0%, Zinc 42.0%, Nickel 10.0%, Manganese 2.0%, Lead 1.0%. An extrusion alloy commonly used in combination with alloy 745 (Nickel Silver 65-10). Good mechanical properties. Excellent hot forming but poor cold forming characteristics. Readily soldered and brazed, but has only fair to poor welding qualities. Natural color — warm silver.

Drawn Tubular Forms

For mullions, sash, doors and frames, handrails, trim, etc.:

Alloy 230 (Red Brass)

Principal alloy used for architectural applications requiring closed shapes. Good mechanical properties and forming characteristics. Readily soldered and brazed, but welding qualities are only fair to poor. Natural color — reddish yellow; often altered by bichromate dip in process, in order to approximate color of alloys 280 and 385.

Alloy 745 (Nickel Silver 65-10)

Used for color matching closed shapes with alloy 745 sheet and alloy 796 extrusions. Range of sizes and gages is limited. Readily soldered and brazed, and fair to good welding qualities. Natural color — warm silver.

Castings

For decorative panels, hardware items, etc.:

(No standard alloy number assigned)

A copper alloy with the following composition: Copper 81-85%, Tin 2-3%, Lead 2-3%, Nickel 0.25-0.75%, Iron 0.35% max., Other, total 0.50% max., Zinc, remainder. This alloy is used for ornamental sand castings where strength is not a critical requirement. Can be soldered and brazed, but welding qualities are poor. Natural color - high golden yellow; provides good color match with the extrusion alloy 385.

Alloy 973 (Nickel-Silver 12%)

A nickel silver alloy with the following composition: Copper 56%, Zinc 20%, Nickel 12%, Lead 10%, Tin 2%. This alloy is also used for ornamental sand castings where strength is not critical. Provides good color match with extruded Nickel Silver. Readily soldered and brazed, but poor welding qualities. Natural color — warm silver.

Fasteners

Alloy 651 (Low Silicon Bronze B)

Used for full range of medium to high strength nails, screws, bolts and nuts, where color match is not critical. Color is slightly redder than that of alloy 385.

Alloy 655 (High Silicon Bronze A)

Used for special hot headed bolts, or bolts of large diameter or long lengths, where color match is not critical. Color is slightly redder than that of alloy 385.

Alloy 464, 465, 466 & 467 (Naval Brass)

Used for full range of medium strength screws, bolts and nuts. Fair to good color match; slightly yellower than alloy 385.

Alloy 280 (Muntz Metal)

Used for screws, nuts and bolts of relatively low strength, where color match is critical. Excellent color match with alloy 385.

Alloy 485 (Naval Brass-High Leaded)

Used for machined screws, bolts and nuts of medium to low strength. Color is yellow with fair to good color match with alloys 280 and 385.

COLOR MATCHING OF COPPER ALLOYS Alloys to be used in various forms, for best color match with certain sheet and plate alloys (Color of surfaces compared after identical grinding or polishing)						
	Sheet and Plate Alloys					
<i>Forms to be Matched in Color</i>	Alloy 110 Copper	Alloy 220 Commercial Bronze, 90%	Alloy 230 Red Brass 85%	Alloy 260 Cartridge Brass, 70%	Alloy 280 Muntz Metal	Alloy 745 Nickel Silver
<i>Extrusions:</i>	Alloy 110 Copper (simple shapes)		Alloy 385 Architectural Bronze		Alloy 385 Architectural Bronze	Alloy 796 Leaded Nickel Silver
<i>Castings:</i>	Copper (98% pure)		82.0% copper 2.5% tin 2.5% lead 13.0% zinc		82.0% copper 2.5% tin 2.5% lead 13.0% zinc	55.0% copper 2.0% tin 10.5% lead 20.0% zinc 12.5% nickel
<i>Fasteners:</i>	Alloy 651 Low Silicon Bronze (fair)	Alloy 651 Low Silicon Bronze	Alloy 651 Low Silicon Bronze (fair)	Alloy 260 Cartridge Brass, 70%	Alloy 651 Low Silicon Bronze (fair)	Alloy 745 Nickel Silver
			Alloy 280 Muntz Metal	Alloy 360 Free Ctg. Br. Alloys 464 & 485	Alloy 280 Muntz Metal	
<i>Tube and Pipe:</i>	Alloy 122 Copper	Alloy 220 Commercial Bronze, 90%	Alloy 230 Red Brass 85%	Alloy 260 Cartridge Brass, 70%	Alloy 230 Red Brass 85%	Alloy 745 Nickel Silver
<i>Rod and Wire:</i>	Alloy 110 Copper	Alloy 220 Commercial Bronze, 90%	Alloy 230 Red Brass 85%	Alloy 260 Cartridge Brass, 70%	Alloy 280 Muntz Metal	Alloy 745 Nickel Silver
<i>Filler Metal:</i>	Alloy 189 Copper	Alloy 655 High Silicon Bronze	Alloy 655 High Silicon Bronze (fair)	Alloy 681 Low Fuming Bronze (poor)	Alloy 681 Low Fuming Bronze	Alloy 773 Nickel Silver
<p align="center">CHARACTERISTIC COLORS</p> <p>Alloy 110, Copper Salmon Red Alloy 220, Commercial Bronze, 90% Red Gold Alloy 230, Red Brass, 85% Reddish Yellow Alloy 260, Cartridge Brass, 70% Yellow Alloy 280, Muntz Metal Reddish Yellow Alloy 385, Architectural Bronze Reddish Yellow</p>						

METALS

GUIDE FOR THE SELECTION OF STAINLESS STEEL TYPES

All stainless steel falls into three basic groups: the austenitic grades, the ferritic grades and the martensitic grades.

The *austenitic* stainless steels, so named because their metallurgical structure is made up predominantly of austenite, contain both chromium and nickel, and possess the highest corrosion resistance. They are not hardenable by heat treatment and are non-magnetic in their annealed state, though some types become slightly magnetic with cold working. The "200" and "300" series of alloys belong to this family.

The *ferritic* stainless steel contain 14% or more of chromium, but very little if any nickel. They are not hardenable by heat treatment either, but are always magnetic.

The *martensitic* stainless steels are hardenable by heat treatment and are also magnetic. Steels in this group contain a maximum of 17% chromium, and some alloys contain nickel, and their corrosion resistance is lower than that of the other two groups. They are especially suited for hot working or forging, and consequently find very limited application in architectural uses.

Sheet, Strip, Plate, Bars, Tubing and Extrusions

For all typical applications, such as mullions, panels, fascias, column covers, windows, doors, trim, roofing, gutters, flashing, hardware, etc., where minimum maintenance is anticipated:

Types 302 and 304

These are the most popular types for general architectural use, being referred to as "18-8" stainless (18% chromium, 8% nickel). These austenitic types are easy to form and fabricate, possess high strength and hardness, and consequently have excellent wearing qualities. They are highly corrosion resistant for all normal exposures. Type 304 is more readily weldable and has higher corrosion resistance than Type 302 or 301.

Type 301

Contains slightly less chromium and nickel than Type 302/304 and has slightly higher work hardening characteristics.

NOTE: Types 301, 302 and 304 may be used interchangeably in some applications.

Types 201 and 202

Other austenitic types, containing only about 5% nickel and a relatively high (5 1/2 to 10) percentage of manganese. They have higher strength than Type 302/304

with equally good corrosion resistance, but are a little more difficult to form.

For some interior decorative applications, where regular maintenance will be provided:

Type 430

A "straight chromium" ferritic type which is used chiefly for interior applications and hardware items. Slightly less corrosion resistant than other architectural types, and the lowest in cost.

For applications where severe exposure to marine or seacoast atmospheres or to damaging industrial fumes requires maximum resistance to corrosion:

Type 316

A modification of Type 302/304, with a higher nickel content (averaging 12%) and the addition of 2 to 3% molybdenum. An austenitic alloy, very highly resistant to chemical corrosion as well as marine applications.

Fasteners

For all types of fasteners, in either exposed or protected locations:

Type 303

A more workable type, compatible with Type 302/304 in respect to all of the architectural requirements of appearance, corrosion resistance and durability.

For all types of fasteners in locations protected from weather, where slightly less corrosion resistance is acceptable, at some savings in cost:

Type 410

A widely used martensitic steel with good machinability and mechanical properties.

NOTE: Fasteners may be cadmium plated for the purpose of lubrication.

Types 430F and 430FSe

These are ferritic chromium steels with superior corrosion resistance to Type 410 chromium steel but somewhat less corrosion resistance than the 200 and 300 series types. These are free machining variations of Type 430 and are suitable for production of parts on automatic screw machines.

STANDARD MECHANICAL FINISHES FOR ARCHITECTURAL STAINLESS STEEL

(For Further Information Refer to AISI's Steel Products Manual and Heat Resisting Steels)

METALS

FINISH DESIGNATION	DEFINITION
<i>Unpolished Finishes:</i>	
No. 1*	A rough dull surface produced by hot rolling to the specified thickness, followed by annealing and descaling.
No. 2D* (for widths under 610 mm (24 in) referred to as "No. 1 Strip Finish")	A dull cold rolled finish produced by cold rolling to the specified thickness, followed by annealing and descaling. May also be accomplished by a final light roll pass on dull rolls.
No. 2B* (for widths under 610 mm (24 in) referred to as "No. 2 Strip Finish")	A bright cold rolled finish commonly produced in the same way as No. 2D finish, except that the annealed and descaled sheet receives a final light cold roll pass on polished rolls. This is a general purpose cold rolled finish, and is more readily polished than the No. 1 or No. 2D finishes.
Bright Annealed*	A bright, highly reflective finish produced by annealing in a controlled atmosphere. Commonly used in lieu of No. 8 finish. Primarily a strip finish; used for automotive trim.
<i>Polished Finishes:</i>	
No. 3*	An intermediate polished surface obtained by finishing with a 100 grit abrasive. Generally used where a semi-finished polished surface is required for subsequent finishing operations following fabrication.
No. 4*	A general purpose bright polished surface obtained by finishing with a 120 - 150 mesh abrasive, following initial grinding with coarser abrasives.
No. 6	A soft satin finish having lower reflectivity than No. 4 finish. It is produced by Tampico brushing the No. 4 finish in a medium of abrasive and oil.
No. 7	A highly reflective finish produced by buffing a finely ground surface. Grit lines are not entirely removed.
No. 8	The most reflective finish commonly produced. It is obtained by polishing with successively finer abrasives, then buffing extensively with a very fine buffing compound.
*Normally supplied by the steel producer.	



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