SECTION 08 56 53
BLAST RESISTANT GLAZED SYSTEMS
FOR MISSION CRITICAL RATED BUILDINGS

PART I - GENERAL

1-1 DESCRIPTION

The extent of exterior metal window units required to provide specified resistances is indicated on Contract Drawings by elevations/details/ schedules/notations.

1-2 RELATED DOCUMENTS

A. Glazing and ballistic rated glazing: Section 08 80 00, GLAZING.

B. Physical Security Design Manual (PSDM) July 2007, for Veteran Affair Mission Critical Facilities, Final Draft.

C. WinGARD Version 5.5.1 or later.

1-3 SYSTEM PERFORMANCE

A. General: Fabricate and install window assemblies to achieve indicated levels of resistance. Extend resistance to include anchorages, interfaces with adjoining substrates, glass retention, and hardware. Security attacks shall be unable to penetrate through closed/locked security window assemblies in manner described; it is recognized that such attacks may damage units beyond repair and reuse, requiring replacement.

B. Blast Resistance: Provide resistance as follows:

1. General:

a. Design exterior windows and frames to meet the performance requirements for a ‘Mission Critical’ facility in accordance with the PSDM.

i. The following building has been assigned a VA PSDM status of ‘Mission Critical’:

a) Emergency Services Addition

b. Glazed doors shall be designed such that they seat within a continuous door stop, which is mechanically attached to a door frame. Doors may fail outward in response to blast loading and hardware (i.e. hinges and locks) may fail. Glazing for entrance doors shall be laminated. Mullions and structure serving to support doors shall be designed for blast loading.

2. Acceptable Glass Response:

a. Blast Resistant Window Systems: windows and glazed doors are to meet the equivalent of GSA Performance Condition 3B or better.

Condition 3B is defined as when the glazing breaks, glass fragments enter the space, and land on the floor no further than 10 feet (3 meters) from the window.

3. Window System Design:
   a. Glass Design: Use WinGARD 5.5.1 or latest to design exterior glass panes to resist the lower bound GP2 load.
   b. Supporting Structure: Design framing members and mullions to resist the applied blast load over the glass tributary to the mullion applied over the appropriate effective area of the mullion.
      i. Support Rotation: Limit mullion deformation to no greater than L/30. Analysis must show that glazing will not disengage from the window framing system when mullion rotations exceed 2º or provide a minimum 1/4-in. of structural silicone sealant in accordance with this specification.
   c. Connections: Design connections to the lesser of the following:
      i. Design connections to the average peak dynamic loads from the glazing by distributing the dynamic loads over the perimeter length of the frame or the ultimate resistance of the glass panes over the appropriate tributary area, whichever is greater.
      ii. Sum all mullion reaction forces framing into a connection joint based on each element’s flexural yield capacity.
   d. Connection Safety Factors (SF):
      i. SF = 1 shall be allowed for connection elements that provide a ductile mode of failure (e.g. bolt bearing, tensile yielding, etc.)
      ii. SF = 1.5 shall be used for connection elements that provide a non-ductile mode of failure (e.g. weld fracture, concrete cone failure due to anchor bolt pull-out, etc.)
      iii. Connection assembly may be designed for the lesser of a SF = 1.5 or the strength of the actual failure mechanism in the assembly, provided it is governed by a ductile mode.

e. Spandrel Panels: Analysis should be performed to determine the response of the spandrel glass, panels and/or the back-up wall system. Performance should focus on the limitation of flying debris into occupied space.

i. Glass: Laminated meeting a Performance Condition Level 3B or better.

1-4 SUBMITTALS

A. General: Submit the following in accordance with Section 01 33 23, SHOP DRAWINGS.

1. Shop drawings showing dimensioned details of metal window units. Show application of intended glazing materials. Show typical window unit interior and exterior elevations at not less than 3/4" = 1'-0" (1:20) scale. Indicate how window units, not necessarily including basic sub-frames, are to be subsequently removed/replaced; and how glazing unit removal/replacement is to be accomplished. After final modifications and corrections have been incorporated, submit drawings as AutoCAD files with .DWG extension:

a. Details: Show sections at 3" = 1'-0" (1:5) scale of members indicating construction, size, and thickness of components, together with connections, fastenings, and means of separating dissimilar metals.

B. Calculations: Provide calculations prepared by qualified blast consultant verifying that window and glazing meet specific blast resistance requirements detailed in this Section.

1. Prior to performing engineering calculations intended to address the blast loading identified, submit a description of the technique(s) that will be employed to calculate the response of the system to the defined dynamic loading.

2. Calculation package is to include a summary sheet briefly outlining the following:

a. Evaluation criteria

b. Calculation assumptions

c. Table of results by window type/location

d. Statement of Conformance with specification requirements.

3. Calculation submittal is to be stamped and signed by a registered Professional Engineer whose qualifications meet or exceed Quality Assurance criteria.

4. Submit single degree of freedom (or better) dynamic analysis for window system. Submit engineering calculations to show that window response meets specified performance requirements under design load. Additionally, illustrate that brittle modes of failure (such as shear and buckling) are avoided. These calculations must include, but may not be limited to, analysis of the following:
    a. Glass. Determine glass pane performance using an analysis program such as WinGard (Version 5.5.1 or later), developed by the General Service Administration. If a program other than WinGard is used, it must be approved by the Owner prior to calculations. WinGard calculations provided in the calculation package are to include the complete text rather than the “concise” text printout.
    b. Mullions and framing members. Provide a clear load path from the glass to the primary element and supporting analysis which illustrates each component’s ability to transfer the design load to the primary element. Analysis of primary element shall illustrate flexural and shear capacity. Analysis will include verification that the structural silicone sealant can hold the glass in the frame under design loads.
    c. Anchorage. Analyze the strength of embedded anchor assembly, as well as pull-out and reaction forces shared with the building structure. Analyze the window wall anchor clip inserts and fasteners and assemblies, including bolts and stiffeners. Include exact loadings to be transferred to the building structure in the analysis.
    d. Mechanical Anchors. Mechanical anchor capacities shall be developed from dynamic testing. An International Code Council (ICC-ES) evaluation report showing testing for dynamic loading (i.e. seismic or blast) is to be submitted with calculations.
    e. Supporting structure. Coordination of the window/supporting structure interaction shall be the contractors’ responsibility. The window contractor’s engineer performing blast calculations for the window system shall coordinate loading scenarios with the cladding contractor’s engineer providing design for the exterior cladding system. Forces transmitted from the appropriate window tributary area shall

be the maximum capacity or design loads, whichever is greater, from the glazing area.

5. Analysis is required to verify its ability to develop its plastic capacity without instability. Additional calculations must include, but may not be limited to, analysis of the following:
   a. Global performance of mullion. Analysis shall verify that the plastic moment of the mullion, acting in a composite manner with its individual components, can be attained under maximum calculated deflections. Fasteners between each component shall be designed for the plastic capacity of the mullion.
   b. Lateral torsional buckling. Analysis shall verify the ability of the mullion to provide adequate resistance against lateral torsional buckling under maximum calculated deflections.
   c. Local buckling. Analysis shall verify the ability of the mullion and its individual components and connections to provide adequate resistance against localized buckling along the entire load path under maximum calculated deflections.
   d. Structural silicone stress. Analysis shall verify the capacity of the silicone to retain the glass under maximum calculated deflections.

1-5 QUALITY ASSURANCE

Provide products that meet the requirements of Physical Security Design Manual (PSDM) July 2007, for Veteran Affair Mission Critical Facilities, Final Draft.

A. Engineer: Engage an Engineering Professional to perform dynamic analysis of the Blast Resistant Windows. The Engineer shall have a minimum of 5 years experience performing dynamic analysis for blast resistant design and demonstrable experience designing blast resistant window systems in the past 18 months.

B. Window Bite: The required window system bite must be verified in the field.

C. Installation Orientation: Windows delivered to the construction site are to be clearly labeled as to the proper installation orientation (i.e. laminated pane of glass to be installed as the interior pane.)

1-6 DELIVERY, STORAGE, AND HANDLING

A. Comply with Manufacturer's directions and as required to prevent edge damage or other damage to assembly resulting from effects of moisture,

condensation, temperature changes, direct exposure to sun, and contact with chemical solvents.

B. Deliver prefabricated units to Project as completely assembled units, ready for anchorage into supporting structure, and for interfacing with other work.

1-7 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. American Society for Testing and Materials (ASTM):
ASTM A36/A36M-05..... Standard Specification for Carbon Structural Steel
ASTM A123/A123M-02..... Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM B221-06..... Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

C. National Association of Architectural Metal Manufactures (NAAMM)
AMP 500-505-88.....Metal Finishes Manual

D. Physical Security Design Manual (PSDM) July 2007, for Veteran Affair Mission Critical Facilities, Final Draft.

E. WinGARD Version 5.5.1 or latest

PART II - PRODUCTS

2-1 MANUFACTURER/FABRICATOR

Certified Units: Provide units and sub-frames which are manufactured/fabricated by firms which have produced identical units required for this Project and which have been certified to comply with requirements for levels of resistance to attack specified.

2-2 MATERIALS

A. Steel Shapes/Plates/Bars: ASTM A 36, except where another designation is indicated.

B. Stainless Steel: Provide formed members of AISI Type 304 stainless steel sheet, with No. 4 directional polish.

C. Bolts and Fasteners: Provide AISI Type 300-series stainless steel screws, bolts, nuts, and washers; comply with ASTM A 320. Provide non-removable type where accessible from attack side.

D. Aluminum Extrusions/Bars: Provide members complying with ASTM B 221, alloy 6063-T5, -T6, or -T52, or alloy 6061-T6, for principal framing

members; provide alloy 6063-T5, -T6, or -T52 for trim and stops which are not exposed to forced entry attack.

E. Framing Members:

1. Yield Strength: Provide supporting references that grade of steel or aluminum used is capable of achieving calculated ductility ratio.
2. If dynamic analysis is used, the yield strength of framing members may be increased to account for static increase factors and dynamic strain rate effects as follows:
    a. Structural Steel: For fy = 36 ksi, the yield strength may be increased by a factor of 1.42. For fy = 46 ksi, the yield strength may be increased by a factor of 1.31.
    b. Structural Aluminum: 6063-T6 Alloy – Fy = 25 ksi, the yield strength may be increased by a factor of 1.14, 6061-T6 Alloy – Fy = 35 ksi, the yield strength may be increased by a factor of 1.09.
3. Section Modulus: The plastic section modulus may be used in dynamic design calculations.
4. Built-up Sections: Design built-up sections using ultimate stress and strain compatibility approaches as defined by industry standards. If built-up section is analyzed as one unit, full shear stress transfer along the line of contact between the individual sections must be illustrated.

F. Glazing Materials: Refer to Section 08 80 00.

1. Glass-to-Glass Interlayers: Clear polyvinyl butyrl (PVB) laminating film/sheet shall be used on the inner lite of exterior window systems.
2. Window bite: The minimum allowable bite is 1/2″ [12.7 mm].
3. Probability of Failure. To determine the response of the glass and the anchorage loads, the probability of breakage for the glass is to be 750 breaks per 1000.

G. Structural Silicone Sealant:

1. Ultimate Tensile Stress: Minimum 350 psi in tension.
2. Safety Factors: ultimate tension and shear capacities are to be used with a safety factor of 1.0.
3. Apply the silicone sealant to the interior perimeter of the glass to bond the glass to the frame. The minimum bead size is 1/4″ [6 mm].

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