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SECTION 02630

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SECTION 02630

STORM-DRAINAGE SYSTEM

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

AASHTO HB-16	(1996) Standard Specifications for Highway Bridges
AASHTO M 198	(1998) Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets
AASHTO M 294	(1998) Corrugated Polyethylene Pipe, 300- to 1200- mm Diameter
AASHTO MP7	(1997) Corrugated Polyethylene Pipe, 1350 and 1500 mm Diameter

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION
(AREMA)

AREMA Manual	(1999) Manual for Railway Engineering (4 Vol.)
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AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 48M	(1994 el) Gray Iron Castings (Metric)
ASTM A 276	(1998) Specification for Stainless Steel Bars & Shapes
ASTM A 536	(1999el) Ductile Iron Castings
ASTM A 74	(1998) Cast Iron Soil Pipe and Fittings
ASTM B 26/B 26M	(1998) Aluminum-Alloy Sand Castings
ASTM C 12	(1998el) Installing Vitrified Clay Pipe Lines

ASTM C 32	(1999e1) Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C 55	(1999) Concrete Brick
ASTM C 62	(1997a) Building Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C 76M	(1999a) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric)
ASTM C 139	(1999) Concrete Masonry Units for Construction of Catch Basins and Manholes
ASTM C 231	(1997e1) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 270	(1997) Mortar for Unit Masonry
ASTM C 425	(1998b) Compression Joints for Vitrified Clay Pipe and Fittings
ASTM C 443	(1998) Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C 443M	(1998) Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets (Metric)
ASTM C 478M	(1997) Precast Reinforced Concrete Manhole Sections (Metric)
ASTM C 700	(1999) Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM C 789	(1998) Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers
ASTM C 850	(1998) Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers with Less Than 2 Ft. of Cover Subjected to Highway Loadings
ASTM C 877M	(1994) External Sealing Bands for Noncircular Concrete Sewer, Storm Drain, and Culvert Pipe (Metric)
ASTM D 1056	(1998) Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D 1171	(1994) Rubber Deterioration - Surface Ozone Cracking Outdoors or Chamber

	(Triangular Specimens)
ASTM D 1557	(1998) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))
ASTM D 1751	(1999) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(1984; R 1996el) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D 1784	(1999a) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 2321	(1989; R 1995) Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D 2922	(1996el) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1988; R 1996el) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 3034	(1998) Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3350	(1998a) Polyethylene Plastics Pipe and Fittings Materials
ASTM F 477	(1999) Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 679	(1995) Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM F 714	(1997) Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
ASTM F 794	(1999) Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F 894	(1998a) Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe

ASTM F 949 (1999) Poly(Vinyl Chloride) (PVC)
 Corrugated Sewer Pipe with a Smooth
 Interior and Fittings

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C 105 (1993) Polyethylene Encasement for
 Ductile-Iron Pipe Systems

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Placing Pipe

Printed copies of the manufacturer's recommendations for installation procedures of the material being placed, prior to installation.

SD-07 Certificates

- Resin Certification
- Pipeline Testing
- Determination of Density
- Frame and Cover for Gratings

Certified copies of test reports demonstrating conformance to applicable pipe specifications, before pipe is installed. Certification on the ability of frame and cover or gratings to carry the imposed live load.

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Delivery and Storage

Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. The Contractor shall have a copy of the manufacturer's instructions available at the construction site at all times and shall follow these instructions unless directed otherwise by the Contracting Officer. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install plastic pipe shall be stored in accordance with the manufacturer's recommendations and shall be discarded if the storage period exceeds the recommended shelf

life. Solvents in use shall be discarded when the recommended pot life is exceeded.

1.3.2 Handling

Materials shall be handled in a manner that ensures delivery to the trench in sound, undamaged condition. Pipe shall be carried to the trench, not dragged.

PART 2 PRODUCTS

2.1 PIPE FOR CULVERTS AND STORM DRAINS

Pipe for culverts and storm drains shall be of the sizes indicated and shall conform to the requirements specified.

2.1.1 Concrete Pipe

ASTM C 76M , Class IV or V.

2.1.2 Clay Pipe

Extra strength, conforming to ASTM C 700.

2.1.3 PVC Pipe

The pipe manufacturer's resin certification, indicating the cell classification of PVC used to manufacture the pipe, shall be submitted prior to installation of the pipe.

2.1.3.1 Type PSM PVC Pipe

ASTM D 3034, Type PSM, maximum SDR 35, produced from PVC certified by the compounder as meeting the requirements of ASTM D 1784, minimum cell class 12454-B.

2.1.3.2 Profile PVC Pipe

ASTM F 794, Series 46, produced from PVC certified by the compounder as meeting the requirements of ASTM D 1784, minimum cell class 12454-B.

2.1.3.3 Smooth Wall PVC Pipe

ASTM F 679 produced from PVC certified by the compounder as meeting the requirements of ASTM D 1784, minimum cell class 12454-B.

2.1.3.4 Corrugated PVC Pipe

ASTM F 949 produced from PVC certified by the compounder as meeting the requirements of ASTM D 1784, minimum cell class 12454-B.

2.1.4 PE Pipe

The pipe manufacturer's resin certification indicating the cell

classification of PE used to manufacture the pipe shall be submitted prior to installation of the pipe. The minimum cell classification for polyethylene plastic shall apply to each of the seven primary properties of the cell classification limits in accordance with ASTM D 3350.

2.1.4.1 Smooth Wall PE Pipe

ASTM F 714, maximum DR of 21 for pipes 80 to 600 mm in diameter and maximum DR of 26 for pipes 650 to 1200 mm in diameter. Pipe shall be produced from PE certified by the resin producer as meeting the requirements of ASTM D 3350, minimum cell class 335434C.

2.1.4.2 Corrugated PE Pipe

AASHTO M 294, Type S, for pipes 300 to 1200 mm and AASHTO MP7, Type S, for pipes 1350 to 1500 mm produced from PE certified by the resin producer as meeting the requirements of ASTM D 3350, minimum cell class in accordance with AASHTO M 294. Pipe walls shall have the following properties:

Nominal Size (mm)	Minimum Wall Area (square mm/m)	Minimum Moment of Inertia of Wall Section (mm to the 4th/mm)
300	3200	390
375	4000	870
450	4900	1020
600	6600	1900
750	8300	2670
900	9500	3640
1050	9900	8900
1200	10900	8900
1350	12000	13110
1500	13650	13110

2.1.4.3 Profile Wall PE Pipe

ASTM F 894, RSC 160, produced from PE certified by the resin producer as meeting the requirements of ASTM D 3350, minimum cell class 334433C. Pipe walls shall have the following properties:

Nominal Size (mm)	Minimum Wall Area (square mm/m)	Cell Class 334433C	Cell Class 335434C
450	6300	850	620
525	8800	1150	840
600	9900	1330	970
675	12500	2050	1490
750	12500	2050	1490
825	14800	2640	2160
900	17100	3310	2700
1050	16500	4540	3720
1200	18700	5540	4540

2.1.5 Cast Iron Soil Pipe and Fittings

Cast Iron Soil Pipe meeting the requirements of ASTM A 74, Class SV, shall be used for downspout drains if the minimum cover of 300 mm (12 inches) in grassed areas cannot be met. Cast iron soil pipe and fittings shall be used if the minimum cover of 750 mm (2-1/2 ft) in paved or traffic areas cannot be met. Minimum cover for cast iron soil pipe and fittings in paved areas shall be 450 mm (18 inches). Cast iron soil pipe and fitting shall

be as specified in Section 02531 SANITARY SEWERS. Pipe shall be encased with 8 mm thick polyethylene in accordance with AWWA C 105.

2.2 DRAINAGE STRUCTURES

2.2.1 Precast Reinforced Concrete Box

For highway loadings with 600 mm of cover or more or subjected to dead load only, ASTM C 789; for less than 600 mm of cover subjected to highway loading, ASTM C 850.

2.3 MISCELLANEOUS MATERIALS

2.3.1 Concrete

Unless otherwise specified, concrete and reinforced concrete shall conform to the requirements for 17 MPa (2500 psi) concrete under Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. The concrete mixture shall have air content by volume of concrete, based on measurements made immediately after discharge from the mixer, of 3 to 6 percent. Air content shall be determined in accordance with ASTM C 231. The concrete covering over steel reinforcing shall not be less than 25 mm thick for covers and not less than 40 mm thick for walls and flooring. Concrete covering deposited directly against the ground shall have a thickness of at least 75 mm between steel and ground. Expansion-joint filler material shall conform to ASTM D 1751, or ASTM D 1752, or shall be resin-impregnated fiberboard conforming to the physical requirements of ASTM D 1752.

2.3.2 Mortar

Mortar for pipe joints, connections to other drainage structures, and brick or block construction shall conform to ASTM C 270, Type M, except that the maximum placement time shall be 1 hour. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar but in no case shall exceed 21 liters of water per sack of cement. Water shall be clean and free of harmful acids, alkalies, and organic impurities. The mortar shall be used within 30 minutes after the ingredients are mixed with water. The inside of the joint shall be wiped clean and finished smooth. The mortar head on the outside shall be protected from air and sun with a proper covering until satisfactorily cured.

2.3.3 Precast Concrete Segmental Blocks

Precast concrete segmental block shall conform to ASTM C 139, not more than 200 mm (8 inches) thick, not less than 200 mm (8 inches) long, and of such shape that joints can be sealed effectively and bonded with cement mortar.

2.3.4 Brick

Brick shall conform to ASTM C 62, Grade SW; ASTM C 55, Grade S-I or S-II; or ASTM C 32, Grade MS. Mortar for jointing and plastering shall consist of one part portland cement and two parts fine sand. Lime may be added to the mortar in a quantity not more than 25 percent of the volume of cement.

The joints shall be filled completely and shall be smooth and free from surplus mortar on the inside of the structure. Brick structures shall be plastered with 10 mm of mortar over the entire outside surface of the walls. For square or rectangular structures, brick shall be laid in stretcher courses with a header course every sixth course. For round structures, brick shall be laid radially with every sixth course a stretcher course.

2.3.5 Precast Reinforced Concrete Manholes

Precast reinforced concrete manholes shall conform to ASTM C 478M . Joints between precast concrete risers and tops shall be full-bedded in cement mortar and shall be smoothed to a uniform surface on both interior and exterior of the structure or made with flexible watertight, rubber-type gaskets meeting the requirements of paragraph JOINTS.

2.3.6 Frame and Cover for Gratings

Frame and cover for gratings shall be cast gray iron, ASTM A 48M , Class 35B; cast ductile iron, ASTM A 536, Grade 65-45-12; or cast aluminum, ASTM B 26/B 26M, Alloy 356.OT6. Weight, shape, size, and waterway openings for grates and curb inlets shall be as indicated on the plans.

2.3.7 Joints

2.3.7.1 Flexible Joints

- a. Materials: Flexible joints shall be made with plastic or rubber-type gaskets for concrete pipe and with factory-fabricated resilient materials for clay pipe. The design of joints and the physical requirements for plastic gaskets shall conform to AASHTO M 198, and rubber-type gaskets shall conform to ASTM C 443M . Factory-fabricated resilient joint materials shall conform to ASTM C 425. Gaskets shall have not more than one factory-fabricated splice, except that two factory-fabricated splices of the rubber-type gasket are permitted if the nominal diameter of the pipe being gasketed exceeds 1.35 m (54 inches).
- b. Test Requirements: Flexible joints shall be tested and shall meet test requirements of paragraph Pipeline Testing.

2.3.7.2 External Sealing Bands

Requirements for external sealing bands shall conform to ASTM C 877M .

2.3.7.3 Flexible, Gasketed Joints

- a. Gaskets: When exfiltration is a concern for pipe lines, the couplings may be required to have gaskets. The closed-cell expanded rubber gaskets shall be a continuous band approximately 178 mm (7 inches) wide and approximately 10 mm (3/8 inch) thick, meeting the requirements of ASTM D 1056, Type 2 A1, and shall have a quality retention rating of not less than 70 percent when tested for weather resistance by ozone chamber exposure, Method B of ASTM

D 1171. Rubber O-ring gaskets shall be 21 mm (13/16 inch) in diameter for pipe diameters of 914 mm (36 inches) or smaller and 22 mm (7/8 inch) in diameter for larger pipe having 13 mm (1/2 inch) deep end corrugation. Rubber O-ring gaskets shall be 35 mm (1-3/8 inches) in diameter for pipe having 25 mm (1 inch) deep end corrugations. O-rings shall meet the requirements of AASHTO M 198 or ASTM C 443 . Flexible plastic gaskets shall conform to requirements of AASHTO M 198, Type B.

- b. Connecting Bands: Connecting bands shall be of the type, size and sheet thickness of band, and the size of angles, bolts, rods and lugs as indicated or where not indicated as specified in the applicable standards or specifications for the pipe. Exterior rivet heads in the longitudinal seam under the connecting band shall be countersunk or the rivets shall be omitted and the seam welded. Watertight joints shall be tested and shall meet the test requirements of paragraph HYDROSTATIC TEST ON WATERTIGHT JOINTS.

2.3.7.4 PVC Plastic Pipes

Joints shall be solvent cement or elastomeric gasket type in accordance with the specification for the pipe and as recommended by the pipe manufacturer.

2.3.7.5 Smooth Wall PE Plastic Pipe

Pipe shall be joined using butt fusion method as recommended by the pipe manufacturer.

2.3.7.6 Corrugated PE Plastic Pipe

Water tight joints shall be made using a PVC or PE coupling and rubber gaskets as recommended by the pipe manufacturer. Rubber gaskets shall conform to ASTM F 477. Soil tight joints shall conform to the requirements in AASHTO HB-16, Division II, Section 26.4.2.4. (e) for soil tightness and shall be as recommended by the pipe manufacturer.

2.3.7.7 Profile Wall PE Plastic Pipe

Joints shall be gasketed or thermal weld type with integral bell in accordance with ASTM F 894.

2.3.7.8 Ductile Iron Pipe

Couplings and fittings shall be as recommended by the pipe manufacturer.

2.4 STAINLESS STEEL LADDER

Steel ladder shall be provided where the depth of the manhole exceeds 1 m (3 feet). These ladders shall be not less than 406 mm (16 inches) in width, with 19 mm (3/4 inch) diameter rungs spaced 305 mm (12 inches) apart. The two stringers shall be a minimum 10 mm (3/8 inch) thick and 63 mm (2-1/2 inches) wide.

Ladders and inserts shall be fabricated of AISI Type 304 stainless steel in conformance with ASTM A 276.

2.5 DOWNSPOUT BOOTS

Boots used to connect exterior downspouts to the storm-drainage system shall be of gray cast iron conforming to ASTM A 48M , Class 30B or 35B. Shape and size shall be as indicated.

PART 3 EXECUTION

3.1 EXCAVATION FOR PIPE CULVERTS, STORM DRAINS, AND DRAINAGE STRUCTURES

Excavation of trenches, and for appurtenances and backfilling for culverts and storm drains, shall be in accordance with the applicable portions of Section 02316 "Excavation, Trenching, and Backfilling for Utilities Systems and the requirements specified below.

3.1.1 Trenching

The width of trenches at any point below the top of the pipe shall be not greater than the outside diameter of the pipe plus 600 mm to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Sheeting and bracing, where required, shall be placed within the trench width as specified. Contractor shall not overexcavate. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures will be necessary. Cost of this redesign and increased cost of pipe or installation shall be borne by the Contractor without additional cost to the Government.

3.1.2 Removal of Rock

Rock in either ledge or boulder formation shall be replaced with suitable materials compacted to 95% of max density as determined by ASTM D 1557 S4C to provide a compacted earth cushion having a thickness between unremoved rock and the pipe of at least 200 mm or 13 mm for each meter of fill over the top of the pipe, whichever is greater, but not more than three-fourths the nominal diameter of the pipe. Where bell-and-spigot pipe is used, the cushion shall be maintained under the bell as well as under the straight portion of the pipe. Rock excavation shall be as specified and defined in Section 02316 "Excavation, Trenching, and Backfilling for Utilities Systems".

3.1.3 Removal of Unstable Material

Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the Contracting Officer, is unexpectedly encountered in the bottom of a trench, such material shall be removed to the depth required and replaced to the proper grade with S4C material, compacted as provided in paragraph BACKFILLING. When removal of unstable material is due to the fault or neglect of the Contractor in his performance of shoring and sheeting, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to the government.

3.2 BEDDING

The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe.

3.2.1 Concrete Pipe Requirements

When no bedding class is specified or detailed on the drawings, concrete pipe shall be bedded in a soil foundation accurately shaped and rounded to conform to the lowest one-fourth of the outside portion of circular pipe or to the lower curved portion of pipe arch for the entire length of the pipe or pipe arch. When necessary, the bedding shall be tamped. Bell holes and depressions for joints shall be not more than the length, depth, and width required for properly making the particular type of joint.

3.2.2 Clay Pipe Requirements

Bedding for clay pipe shall be as specified by ASTM C 12.

3.2.3 Plastic Pipe

Plastic pipes shall have S4C bedding material placed 100 mm (4 inch) below the bottom of the pipe. Bedding shall be compacted to 95% of max density as determined by ASTM D 1557. Bedding for PVC and PE pipe shall meet the requirements of ASTM D 2321. Bedding, haunching, and initial backfill shall be either Class IB or II material.

3.3 PLACING PIPE

Each pipe shall be thoroughly examined before being laid; defective or damaged pipe shall not be used. Plastic pipe shall be protected from exposure to direct sunlight prior to laying, if necessary to maintain adequate pipe stiffness and meet installation deflection requirements. Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Lifting lugs in vertically elongated metal pipe shall be placed in the same vertical plane as the major axis of the pipe. Pipe shall not be laid in water, and pipe shall not be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary. Deflection of installed flexible pipe shall not exceed the following limits:

TYPE OF PIPE	MAXIMUM ALLOWABLE DEFLECTION (%)
Plastic	7.5
Others	as recommended by manufacturer

Not less than 30 days after the completion of backfilling, the Government may perform a deflection test on the entire length of installed flexible pipe using a mandrel or other suitable device. Installed flexible pipe

showing deflections greater than those indicated above shall be retested by a run from the opposite direction. If the retest also fails, the suspect pipe shall be replaced at no cost to the Government.

3.3.1 Concrete, Clay, PVC, Ribbed PVC and Ductile Iron Pipe

Laying shall proceed upgrade with spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow.

3.3.2 Corrugated PE Pipe

Laying shall be with the separate sections joined firmly on a bed shaped to line and grade and shall follow manufacturer's recommendations.

3.3.3 Multiple Culverts

Where multiple lines of pipe are installed, adjacent sides of pipe shall be at least half the nominal pipe diameter or 1 meter apart, whichever is less.

3.3.4 Jacking Pipe Through Fills

Methods of operation and installation for jacking pipe through fills shall conform to requirements specified in Volume 1, Chapter 1, Part 4 of AREMA Manual.

3.4 JOINTING

3.4.1 Concrete and Clay Pipe

3.4.1.1 Flexible Joints

Gaskets and jointing materials shall be as recommended by the particular manufacturer in regard to use of lubricants, cements, adhesives, and other special installation requirements. Surfaces to receive lubricants, cements, or adhesives shall be clean and dry. Gaskets and jointing materials shall be affixed to the pipe not more than 24 hours prior to the installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Gaskets and jointing materials shall be inspected before installing the pipe; any loose or improperly affixed gaskets and jointing materials shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pushed home. If, while the joint is being made the gasket becomes visibly dislocated the pipe shall be removed and the joint remade.

3.5 DRAINAGE STRUCTURES

3.5.1 Manholes and Inlets

Construction shall be of reinforced concrete, plain concrete, brick, precast reinforced concrete, complete with frames and covers or gratings; and with fixed stainless steel ladders where indicated. Pipe connections to concrete manholes and inlets shall be made with flexible, connectors.

3.5.2 Walls and Headwalls

Construction shall be as indicated.

3.6 STAINLESS STEEL LADDER INSTALLATION

Ladder shall be adequately anchored to the wall by means of stainless steel inserts spaced not more than 1.83 m (6 feet) vertically, and shall be installed to provide at least 152 mm (6 inches) of space between the wall and the rungs. The wall along the line of the ladder shall be vertical for its entire length.

3.7 BACKFILLING

3.7.1 Backfilling Pipe in Trenches

After the pipe has been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of pipe in layers not exceeding 150 mm in compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. The fill shall be thoroughly compacted under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation of at least 300 mm above the top of the pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical rammers or tampers in layers not exceeding 150 millimeters. Tests for density shall be made as necessary to ensure conformance to the compaction requirements specified below. Where it is necessary, in the opinion of the Contracting Officer, that sheeting or portions of bracing used be left in place, the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.

3.7.2 Backfilling Pipe in Fill Sections

For pipe placed in fill sections, backfill material and the placement and compaction procedures shall be as specified below. The fill material shall be uniformly spread in layers longitudinally on both sides of the pipe, not exceeding 150 mm in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 300 mm above the top of the pipe shall extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 4 m, whichever is less. After the backfill has reached at least 300 mm above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 150 mm.

3.7.3 Movement of Construction Machinery

When compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert or storm drain at any stage of construction shall be at the Contractor's risk. Any damaged pipe shall be repaired or replaced.

3.7.4 Compaction

3.7.4.1 General Requirements

Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Cohesive materials include clayey and silty gravels, gravel-silt mixtures, clayey and silty sands, sand-clay mixtures, clays, silts, and very fine sands. When results of compaction tests for moisture-density relations are recorded on graphs, cohesionless soils will show straight lines or reverse-shaped moisture-density curves, and cohesive soils will show normal moisture-density curves.

3.7.4.2 Minimum Density

Backfill over and around the pipe and backfill around and adjacent to drainage structures shall be compacted at the approved moisture content to the following applicable minimum density, which will be determined as specified below.

- a. Under paved roads, streets, parking areas, and similar-use pavements including adjacent shoulder areas, the density shall be not less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material, up to the elevation where requirements for pavement subgrade materials and compaction shall control.
- b. Under unpaved or turfed traffic areas, density shall not be less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material.
- c. Under nontraffic areas, density shall be not less than that of the surrounding material.

3.7.5 Determination of Density

Testing shall be the responsibility of the Contractor and performed at no additional cost to the Government. Testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. Tests shall be performed in sufficient number to ensure that specified density is being obtained. Laboratory tests for moisture-density relations shall be made in accordance with ASTM D 1557 except that mechanical tampers may be used provided the results are correlated with those obtained with the specified hand tamper. Field density tests shall be determined in accordance with ASTM D 1556 or ASTM D 2922. When ASTM D 2922 is used, the calibration curves shall be checked and adjusted, if necessary, using the sand cone method as described in paragraph Calibration of the referenced publications. ASTM D 2922 results in a wet unit weight of soil and when using this method ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D 3017 or ASTM D 2922. Test results shall be furnished the Contracting Officer. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each

different type of material encountered and at intervals as directed.

3.8 PIPELINE TESTING

Concrete pipelines shall be tested for leakage by exfiltration tests. An exfiltration test shall be made by filling the line to be tested with water so that a head of at least 600 mm is provided above both the water table and the top of the pipe at the upper end of the pipeline to be tested. The filled line shall be allowed to stand until the pipe has reached its maximum absorption, but not less than 4 hours. After absorption, the head shall be reestablished. The amount of water required to maintain this water level during a 2-hour test period shall be measured. Leakage as measured by the exfiltration test shall not exceed 9 mL per mm in diameter per 100 meters (0.2 gallons per inch in diameter per 100 feet) of pipeline per hour. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished. Testing, correcting, and retesting shall be made at no additional cost to the Government.

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SECTION 08520

ALUMINUM AND ENVIRONMENTAL CONTROL ALUMINUM WINDOWS

PART 1 GENERAL

1.1 REFERENCES

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

ALUMINUM ASSOCIATION (AA)

AA DAF-45 (1997) Designation System for Aluminum Finishes

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 101 (1997) Voluntary Specifications for Aluminum, Vinyl (PVC) and Wood Windows and Glass Doors

AAMA 605 (1998) voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 90 (1999) Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions

ASTM E 283 (1991) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

ASTM E 330 (1997e1) Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference

ASTM E 413 (1987; R 1999) Rating Sound Insulation

ASTM E 547 (1996) Water Penetration of Exterior Windows, Curtain Walls, and Doors by Cyclic Static Air Pressure Differential

INSECT SCREENING WEAVERS ASSOCIATION (ISWA)

ISWA IWS 089 (1990) Recommended Standards and Specifications for Insect Wire Screening (Wire Fabric)

NATIONAL FENESTRATION RATING COUNCIL (NFRC)

NFRC 100 (1997) Procedure for Determining Fenestration Product U-factors

NFRC 200 (1997) Procedure for Determining Fenestration Product Solar Heat Gain Coefficients at Normal Incidence

SCREEN MANUFACTURERS ASSOCIATION (SMA)

SMA ANSI/SMA 1004 (1987) Aluminum Tubular Frame Screens for Windows

1.2 WINDOW PERFORMANCE

Aluminum windows shall meet the following performance requirements. Testing requirements shall be performed by an independent testing laboratory or agency.

1.2.1 Structural Performance

Structural test pressures on window units shall be for positive load (inward) and negative load (outward) in accordance with ASTM E 330. After testing, there shall be no glass breakage, permanent damage to fasteners, hardware parts, support arms or actuating mechanisms or any other damage which could cause window to be inoperable. There shall be no permanent deformation of any main frame, sash or ventilator member in excess of the requirements established by AAMA 101 for the window types and classification specified in this section.

1.2.2 Air Infiltration

Air infiltration shall not exceed the amount established by AAMA 101 for each window type when tested in accordance with ASTM E 283.

1.2.3 Water Penetration

Water penetration shall not exceed the amount established by AAMA 101 for each window type when tested in accordance with ASTM E 547.

1.2.4 Sound Attenuation

The window unit shall have a minimum STC of 41 with the window glazed with two pieces of 6 mm thick laminated glass with the window glazed with 13 mm air space between two pieces of 6 mm thick glass when tested in accordance with ASTM E 90 and ASTM E 413.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Aluminum Windows
Insect Screens

Drawings indicating elevations of window, rough-opening dimensions for each type and size of window, full-size sections, thicknesses of metal, fastenings, methods of installation and anchorage, connections with other work, type of wall construction, size and spacing of anchors, method of glazing, types and locations of operating hardware, mullion details, weatherstripping details, screen details including method of attachment, and window schedules showing locations of each window type.

SD-03 Product Data

Aluminum Windows

Manufacturer's descriptive data and catalog cut sheets.

Aluminum Windows

Manufacturer's preprinted installation instructions and cleaning instructions.

SD-04 Samples

Aluminum Windows

Manufacturer's standard color samples of the specified finishes.

SD-06 Test Reports

Aluminum Windows

Reports for each type of aluminum window attesting that identical windows have been tested and meet all performance requirements established under paragraph WINDOW PERFORMANCE.

SD-07 Certificates

Aluminum Windows

Certificates stating that the aluminum windows are AAMA certified conforming to requirements of this section. Labels or markings permanently affixed to the window will be accepted in

lieu of certificates. Product ratings determined using NFRC 100 and NFRC 200 shall be authorized for certification and properly labeled by the manufacturer.

1.4 QUALIFICATION

Window manufacturer shall specialize in designing and manufacturing the type of aluminum windows specified in this section, and shall have a minimum of 5 years of documented successful experience. Manufacturer shall have the facilities capable of meeting contract requirements, single-source responsibility and warranty.

1.5 DELIVERY AND STORAGE

Aluminum windows shall be delivered to project site and stored in accordance with manufacturer's recommendations. Damaged windows shall be replaced with new windows.

1.6 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period shall be provided.

PART 2 PRODUCTS

2.1 ALUMINUM WINDOW TYPES

Aluminum windows shall consist of complete units including sash, glass, frame, weatherstripping, and hardware. Windows shall conform to AAMA 101. Windows shall be single-glazed. Operable windows shall permit cleaning the outside glass from inside the building.

2.1.1 Awning/Hopper/Projected Windows

Aluminum awning (A), hopper and projected windows shall conform to AAMA 101 Designation AP-HC40 type consisting of hinged ventilators arranged in a single or vertical series within a common frame. Ventilators shall be operated by a device which shall securely close the ventilator at both jambs without the use of additional manually-controlled locking device equipped with concealed four-bar friction hinges. Operating hardware, except ventilator arms and rotary operators, shall be concealed within frame and sill. Ventilator arms shall be concealed when windows are closed.

2.1.2 Single-Hung and Double-Hung Windows

Aluminum single-hung (H) and double-hung windows shall conform to AAMA 101 H-HC40 type which operate vertically with the weight of sash offset by a counterbalancing mechanism mounted in window to hold the sash stationary at any open position. Windows shall be provided with a tilt-in sash. Single-hung windows shall be provided with locking devices to secure the sash in the closed position. Counterbalancing mechanisms shall be easily replaced after installation.

2.1.3 Fixed Windows

Aluminum fixed (F) windows shall conform to AAMA 101 F-HC40 type, non-operable glazed frame, complete with provisions for reglazing in the field.

2.1.4 Horizontal-Sliding Windows

Aluminum horizontal (HS) sliding windows shall conform to AAMA 101 HS-HC40 type consisting of sliding sash and fixed lite. Sash guides shall be nylon wheels. Windows shall be provided with locking devices to secure the sash in the closed position. In addition, a locking, pin (night lock) shall be provided to secure the window at a slightly opened position.

2.2 WEATHERSTRIPPING

Weatherstripping for ventilating sections shall be of type designed to meet water penetration and air infiltration requirements specified in this section in accordance with AAMA 101, and shall be manufactured of material compatible with aluminum and resistant to weather. Weatherstrips shall be factory-applied and easily replaced in the field. Neoprene or polyvinylchloride weatherstripping are not acceptable where exposed to direct sunlight.

2.3 INSECT SCREENS

Insect screens shall be aluminum window manufacturer's standard design, and shall be provided where scheduled on drawings. Screens shall be single-sliding outside-mounted type. Insect screen shall be designed for the type of window with which they will be used and shall be interchangeable with other units of the same size and type. Insect screens shall be fabricated of roll-formed tubular-shaped aluminum frames conforming to SMA ANSI/SMA 1004 and (18 x 16) aluminum mesh screening conforming with ISWA IWS 089, Type III. Roll-formed tubular shaped stainless steel frames conforming to SMA ANSI/SMA 1004 and (18 x 16) bronze mesh screening conforming with ISWA IWS 089, Type I.

2.4 ACCESSORIES

2.4.1 Fasteners

Fastening devices shall be window manufacturer's standard design made from aluminum, stainless steel, cadmium-plated steel, nickel/chrome-plated steel in compliance with AAMA 101. Self-tapping sheet metal screws will not be acceptable for material thicker than 2 mm

2.4.2 Hardware

Hardware shall be as specified for each window type and shall be fabricated of aluminum, stainless steel, cadmium-plated steel, zinc-plated steel or nickel/chrome-plated steel in accordance with requirements established by AAMA 101.

2.4.3 Window Anchors

Anchoring devices for installing windows shall be made of aluminum, cadmium-plated steel, stainless steel, or zinc-plated steel conforming to AAMA 101

2.4.4 Window Cleaner Anchors

Window cleaning anchors shall be as specified in Section 05500 MISCELLANEOUS MATERIALS.

2.4.5 Grilles

Provide manufacturer's standard exterior grilles for modules as indicated to match window finish.

2.5 GLASS AND GLAZING

Aluminum windows shall be designed for inside glazing, field glazing, and for glass types scheduled on drawings and specified in Section 08810 GLASS AND GLAZING. Units shall be complete with glass and glazing provisions to meet AAMA 101. Glazing material shall be compatible with aluminum, and shall not require painting.

2.6 FINISH

Provide anodize finish except where required color cannot be achieved through anodizing process.

2.6.1 Anodized Aluminum Finish

Exposed surfaces of aluminum windows shall be finished with anodic coating conforming to AA DAF-45: Architectural Class I, AA-M10-C22-A44, color anodic coating, 0.02 mm (0.7 mil) or thicker. Finish shall be free of scratches and other blemishes.

2.6.2 High-Performance Coating

Exposed surfaces of aluminum windows shall be finished with a two-coat fluoropolymer coating system containing at least 70 percent by weight polyvinylidene fluoride, PVF2 resin, factory-applied, oven-baked, conforming to AAMA 605, with a primer coat of 0.005 to 0.008 mm (0.20 to 0.030 mils) and a color coat of minimum 0.025 mm (1.0 mils), total dry film thickness of 0.030 to 0.033 mm (1.2 to 1.3 mils). Finish shall be free of scratches and other blemishes.

2.6.3 Color

Color shall be as indicated.

PART 3 EXECUTION

3.1 INSTALLATION

Aluminum windows shall be installed in accordance with approved shop drawings and manufacturer's published instructions. Aluminum surfaces in

contact with masonry, concrete, wood and dissimilar metals other than stainless steel, zinc, cadmium or small areas of white bronze, shall be protected from direct contact using protective materials recommended by AAMA 101. The completed window installation shall be watertight in accordance with Section 07900 JOINT SEALING. Glass and glazing shall be installed in accordance with requirements of this section and Section 08810 GLASS AND GLAZING.

3.2 ADJUSTMENTS AND CLEANING

3.2.1 Hardware Adjustments

Final operating adjustments shall be made after glazing work is complete. Operating sash or ventilators shall operate smoothly and shall be weathertight when in locked position.

3.2.2 Cleaning

Aluminum window finish and glass shall be cleaned on exterior and interior sides in accordance with window manufacturer's recommendations. Alkaline or abrasive agents shall not be used. Precautions shall be taken to avoid scratching or marring window finish and glass surfaces.

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SECTION 08580

BLAST RESISTANT WINDOWS FOR EXTERNAL ENVELOPE

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 603.8	Voluntary Performance Requirements and Test Procedures for Pigmented Organic Coatings on Extruded Aluminum
AAMA/NWDA 101 I.S.2	(1997) Voluntary Specifications for Aluminum, Vinyl (PVC) and Wood Windows and Glass Doors
AAMA 907	(1996) Voluntary Specification for Corrosion Resistant coatings on Carbon Steel Components
AAMA 800	(1992) Voluntary Specification and Test Methods for Sealants
AAMA 850	(1991) Fenestration Sealants Guide Manual

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 1036	(1991; R1997) Flat Glass
ASTM C 1048	(1997b) Heat Treated Flat Glass - Kind HS, Kind FT Coated and Uncoated Glass
ASTM E 119	(1995a) Fire Tests of Building Construction and Materials
ASTM E 1300	(1998) Standard Practice for Determining Load Resistance of Glass in Buildings

GLASS ASSOCIATION OF NORTH AMERICA (GANA)

GAN-04 (1995) Engineering Standards Manual

GAN-GM (1997) Glazing Manual

British Standards (BS)

BS 5889 (1989) Specification for One Part Gun Grade Silicon Based Sealants.

1.2 GENERAL REQUIREMENTS

Provide and install window units as indicated on the drawings, including glazing, closure trim, stool, hardware, anchors, fasteners, and sub-frames required to install blast resistant punch and ribbon windows in the external envelope of the building, unless noted otherwise.

1.3 QUALIFICATIONS

The Contractor shall select a window manufacturer capable of providing required quality and quantities in accordance with the approved contract schedule.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Windows; G.
Glass; G.
Setting Materials; G.
Fasteners; G.
Accessories; G.
Subframe; G.
Hardware; G.

Data on windows consisting of catalog cuts, brochures, circulars, specifications, and product data that show complete dimensions and completely describe overpressure ratings, rebound ratings, windows, frames, anchors, hardware, and accessories. Submit installation details and instructions for each type of window proposed.

Certification of system performance

Results of full-scale testing with appropriate technical commentary. These test results shall demonstrate the ability of the windows to meet the design blast load requirements.

Detailed engineering analysis demonstrating resistance to blast specified in paragraph "Structural Performance". The analysis shall cover initial response, rebound, and all secondary items such as shear, welds, local buckling, web crippling, hinges, and latches. The analysis shall further include a sketch of the overpressure waveform and dimensioned sketches of blast resisting elements. The analysis shall be certified by a Professional Engineer registered in the United States. This submittal is only required if full-scale testing is not accomplished.

SD-04 Drawings

Windows; G.

The drawing package shall be conventional shop drawings and shall indicate elevations of units, full-size sections depicting sight lines, type of materials, thicknesses of materials, glazing setting method, connections with other work including installation mechanisms and details, and window elevations showing location of each window unit. Include proposed method of anchoring, size and spacing of anchors, and details of construction.

SD-07 Schedules

Window Units; G.

Submit delivery schedule with drawings indicating location of each window unit of each type, by floor, keyed into submittal elevations. All delivery milestones shall be referenced relative to the date that a notice to proceed is given to the awarded window vendor.

SD-09 Reports

Minimum condensation resistance factor.
Deflection.
Air infiltration.
Water penetration.
Blast resistance test reports; G

Certified test reports demonstrating blast resistance. Test reports shall include the name and location of the testing agency or laboratory, a description of the testing apparatus, the date of the tests, a description of the window specimen tested, descriptions of loading(s), and the value of measured window and frame peak permanent displacement. Test reports shall include analysis and interpretation of test results.

SD-13 Certificates

Window units; G.

Certificates shall state that all proposed windows units, including glazing, conform to the specified performance

requirements. A certificate stating that window and frame provided was manufactured using the same materials, dimensions, and tolerances as the blast-resistance tested prototype and listing the hardware and frame anchors required to achieve blast resistance shall be provided. An official authorized to certify on behalf of the manufacturer shall sign each certificate.

SD-14 Samples

Window units; G.

Submit one full-size window of each type proposed for use, complete with manufacturer's label, fastening anchors, and other accessories.

SD-19 Operation and Maintenance Manuals

Window units; G.

1.5 DELIVERY, STORAGE AND PROTECTION

Contractor shall deliver windows in accordance with the approved project schedule. Contractor shall protect windows and associated materials in accordance with manufacturer's recommendations and shall replace with new, any windows damaged during Contractor delivery, Contractor storage or Contractor installation.

1.6 SYSTEM PERFORMANCE REQUIREMENTS AND TESTING

Provide window units that comply with performance requirements specified herein, as demonstrated by certified testing.

1.6.1 Air Infiltration

Provide units with an air infiltration rate, as defined in the test standard ASTM E 283, of not more than 0.10 CFM/minimum/per sq. ft. of wall area measured at a differential pressure across the assembly of 6.24 psf.

1.6.2 Water Penetration

Provide units with no water penetration, as defined in the test standard ASTM E 331, measured at a differential pressure across the assembly of 8.00 LBF per square foot.

1.6.3 Structural Performance

a. Windows and connections shall comply with a minimum performance condition of 3B as defined in accordance with the GSA Security Design Criteria. The frame may deform, but shall not pull out of the wall or subframe. No fragments of glass heavier than 1.5 grams shall penetrate into the protected space in zone 3B or beyond. Windows and frames shall be designed to withstand the blast pressures shown on the structural drawings. The glass and interior layer shall remain in the frame under the blast pressures indicated.

b. Blast tests, if used on a prototype window assembly, shall demonstrate that the window will resist the overpressure waveform at the performance specified. The overpressure waveform used in the test shall meet or exceed the design overpressure waveform in both peak overpressure and peak impulse. Blast tests will be accepted only if the window and frame proposed are manufactured using the same materials and methods as those in the prototype blast tests.

1.6.4 DELETED

1.7 WARRANTY

Window units shall be provided with manufacturer's standard 10-year warranty from time of installation. Installation shall be performed by a certified installer and in conformance with manufacturer's warranty conditions.

1.8 QUALITY ASSURANCE

1.8.1 Standards

Comply with applicable recommended specification(s) of recognized national or international industry standards for window materials.

1.8.2 Prior Production History

Provide a description of the windows and glazing produced by the window manufacturer which shows prior production of units similar to those specified, in similar quality, quantity and schedule requirements.

1.8.3 Design Concepts

The project drawings indicate typical sizes, sight line, profiles and dimensional requirements of the required window types and are based upon existing window sizes, sight lines, profiles and dimensions.

1.9 FIELD MEASUREMENTS

The Contractor shall field verify applicable existing conditions and dimensions as required for correct installation, and shall record field dimensions and quantities on the submitted shop drawings.

1.10 MOCK-UPS

Before fabrication, a full-size mock-up of each main type of window

complete with glass and manufacturer's certification is required for the review of window construction and adherence to the guidelines set forth by the architect. The approval of mock-up shall establish the minimum standard of quality required for all windows. Mock-ups shall be in an actual opening and may be used as part of the work.

1.11 EXTRA MATERIALS

Provide a quantity of 10% additional windows, but not less than 1 additional window, including glazing, in unopened cartons.

PART 2 PRODUCTS

2.1 EXTERIOR WINDOWS

Windows shall be aluminum or steel and shall conform to the appropriate referenced standards or comparable approved standards. Windows and trim shall be of the type and size indicated and shall fully comply with the approved architectural drawings. Windows shall be cleaned, properly prepared, pre-treated, and coated with the specified finish. The Contractor shall coordinate all components of the window with applicable interior finishes, such that components are concealed from view and do not infringe into the interior of the adjacent spaces.

2.1.1 Windows

a. Construction: Windows shall be constructed per national or international industry standards for the window system proposed. Frame members shall be accurately formed and coped to their respective intersecting parts. All surfaces shall be smooth. All welds, if used, shall be ground smooth. The window metal frame shall be thermally broken from the exterior. The heat transfer through the frame shall not exceed that specified. Sash stiles, if provided, shall have double flanges, entering into and operating in deep weathering grooves of the frame stiles. Incorporate integral weathering. Muntins shall have accurately joined intersections and be standard type, rigidly attached to the sash. Sash balances, if provided, shall be concealed within the sash.

b. Operators: Operators shall be capable of keeping the windows in the closed position during the design blast event.

c. Glazing: Sash shall be equipped with meeting rails and glazing stops of a type necessary to receive glass units. The glazing bite shall be no less than 1.5 inches, unless otherwise demonstrated through testing. The glass will be bonded to the frame by low modulus silicone in accordance with BS 5889, AAMA 800 and AAMA 850. Contractor is not required to provide separate glazing panels corresponding to indicated mullion configuration. Instead, the Contractor may provide large glazing panels subdivided with surface applied mullions and/or muntins.

2.2 FASTENERS

Fasteners shall be provided of a material in accordance with AAMA/NWWDA 101 I.S.2, warranted by the manufacturer to be non-corrosive and compatible with the window members, trim, hardware, anchors and other components.

2.3 ANCHORS, CLIPS AND WINDOW ACCESSORIES

Anchors, clips, stops and window accessories shall be provided to comply with AAMA/NWWDA 101 I.S.2 and AAMA 907. Provide units and anchorage mechanism with sufficient strength to withstand required design pressure and strength for specified load conditions. The strength capacity of the anchoring system shall be demonstrated by analysis or in a full-scale blast test using the proposed anchoring system for use in the final installation and tested in a window opening of reinforced concrete of a thickness not more than 8 inches thick. Fasteners, clips and window accessories shall be capable of delivering blast and rebound reactions to the adjacent structure.

2.4 SUBFRAME

An integral window subframe will be provided and built into the structure prior to installation of the frame in accordance with the architectural drawings. The subframe and subframe anchors shall be capable of transferring blast and rebound reactions to the adjacent structure, and the frame shall be capable of transferring these reactions to the subframe. The gap between the subframe and the adjacent structure will be sealed with an EPDM sheet.

2.5 HARDWARE

All exterior hardware shall be constructed of corrosion-resistant materials and will conform to all requirement of AAMA/NWWDA 101 I.S.2. Provide manufacturer's standard interior hardware for the operation indicated. Hardware finish shall be selected from manufacturer's standard finish.

2.6 FINISH

Window finishes shall be shop-applied and will conform to all requirements of AAMA 603.8. Window finishes or finish systems shall have a minimum 15-year warranty. The finishes and associated warranty shall be standard from the manufacturer and the same as available to all buyers. The color and gloss of finishes shall be as indicated on the project drawings or window schedule.

2.7 GLASS

2.7.1 Laminated Glass Units

- a. The glass shall be pre-glazed at the factory in accordance with the instructions of the window manufacturer. The glass shall conform to all requirements of ASTM C 1036. Glass thickness shall meet or exceeds the values given in ASTM E 1300 for the design pressure rating of the project.
- b. The laminated glass will conform to all requirements of ANSI Z 97.1. The laminated glass shall consist of a minimum of two nominal 3 mm

glass panes bonded together with a minimum of a 0.75 mm polyvinyl butral (PVB) inner layer.

2.7.2 Tinted (Light-Reducing) Glass

Tinted (Light-reducing) glass shall be Type I transparent flat type, Class 3-tinted, quality q3 - glazing select, conforming to ASTM C 1036. Thickness, color and light transmission shall be as indicated or as approved.

2.7.3 Tempered Glass

Tempered glass shall be kind FT fully tempered transparent flat type, Class 1-clear, Condition A uncoated surface, Quality q3 - glazing select, conforming to ASTM C 1048 and GANA-04.

2.7.4 Fire/Safety Rated Glass

Fire/safety rated glass shall be laminated Type I transparent flat type, Class 1 - clear. Glass shall have a 20 minute rating when tested in accordance with ASTM E 119. Glass shall be permanently labeled with appropriate markings.

2.8 SETTING MATERIALS

2.8.1 Glazing Compound and Preformed Glazing Sealants

Suitable type in accordance with applicable portions of GANA-GM. Setting materials shall match the window finish, be non-staining, and not require painting. Other materials that will be exposed to view and unpainted shall be black, white or neutral color as on the project drawings or window schedule.

2.8.2 Glazing Accessories

As required to supplement the accessories provided with the items to be glazed and to provide a complete installation, including glazing points, clips, shims, angles, beads, setting blocks, and spacer strips. Ferrous metal accessories that will be exposed in the finished work shall have a finish that will not corrode or stain while in service.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Windows

Install window subframes in accordance with the architectural drawings and the manufacturer's approved installation instructions. Install subframe before the brick and cast stone work. The subframe anchors will have proper devices on which to hang the cast stone sill.

3.1.2 Frame Seals

Seal the gap between the frame and the adjacent structure using an EPDM sheet that will be sealed on both ends with a sealant which is compatible with concrete, finished aluminum and galvanized steel and will conform with all the requirements of B.S 5889. The EPDM sheet shall be installed before starting the brick work.

Install windows in accordance with manufacturer's installation instructions. Install the window prior to the completion of the gypsum board installation at the window head and jambs and the sill board.

3.1.3 Window Seals

Seal window in accordance with the project drawings, manufacturer's approved installation drawings and instructions.

3.2 CLEANING

Window units and glass surfaces shall be thoroughly cleaned with labels, paint spots, putty, and other defacement removed, and shall be clean at the time the work is accepted.

-- End of Section --