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USACE / NAVFAC / AFCESA UFGS-03450 (September 1999)  
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Preparing Activity: NAVFAC Replacing without revision  
NFGS of same number and date

## UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 23 June 2005

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#### SECTION 03450

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09/99

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### SECTION 03450

#### PLANT-PRECAST ARCHITECTURAL CONCRETE 09/99

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NOTE: This guide specification covers the requirements for precast concrete wall panels with normal-weight aggregate portland cement concrete, conventional reinforcing, and smooth surface or exposed aggregate facing.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

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NOTE: The panels specified are intended for attachment of the building framing system at each floor elevation and at the roof elevation. The panels may be provided with built-in anchorage devices for the attachment of thermal insulation blankets to the interior face of the wall panels and for the attachment of metal flashing after the wall panels have been installed.

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Note: Drawings should include a complete design indicating the character of the work to be performed and the following:

1. Location and details of wall panels, showing all dimensions, and size and type of reinforcement.

2. Details of joints between wall panel units, showing sealant or gasket shape, dimensions, and location.

3. Details showing both the location and type of anchorage devices of the panels to the building framing system and the connection of other materials (reglets, insulation nailers, etc.) to the panels. Indicate gravity loads, live loads, dynamic loads, and stresses inherent in the structure for the manufacturer to provide embedded panel anchorage.

4. Locations where flashing reglets are required.

5. Locations of inserts (wedge type, slotted type, etc.) cast into the concrete panels.

6. Location of each type of surface finish, with details of transitions between different types of surface finishes.

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## PART 1 GENERAL

### 1.1 REFERENCES

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NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest guide specification. Use of SpecsIntact automated reference checking is recommended for projects based on older guide specifications.

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

#### ACI INTERNATIONAL (ACI)

ACI 211.1	(1991; R 2002) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 214R	(2002) Evaluation of Strength Test Results of Concrete
ACI 301	(1999) Specifications for Structural Concrete for Buildings
ACI 304R	(2000) Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305R	(1999) Hot Weather Concreting
ACI 306.1	(1990; R 2002) Standard Specification for Cold Weather Concreting

ACI SP-66	(2004) ACI Detailing Manual
AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)	
ANSI B18.21.1	(1994) Lock Washers (Inch Series)
AMERICAN WELDING SOCIETY (AWS)	
AWS D1.1/D1.1M	(2004) Structural Welding Code - Steel
AWS D1.4	(1998) Structural Welding Code - Reinforcing Steel
AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)	
AWPA C1	(2000) All Timber Products - Preservative Treatment by Pressure Processes
AWPA C2	(2001) Lumber, Timber, Bridge Ties and Mine Ties - Preservative Treatment by Pressure Processes
ASTM INTERNATIONAL (ASTM)	
ASTM A 153/A 153M	(2004) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 167	(2004) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 185	(2002) Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A 27/A 27M	(2003) Steel Castings, Carbon, for General Application
ASTM A 283/A 283M	(2003) Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A 36/A 36M	(2004) Carbon Structural Steel
ASTM A 449	(2004a) Quenched and Tempered Steel Bolts and Studs
ASTM A 47	(1999) Ferritic Malleable Iron Castings
ASTM A 47M	(1990; R 1996) Ferritic Malleable Iron Castings (Metric)
ASTM A 496	(2002) Steel Wire, Deformed, for Concrete Reinforcement
ASTM A 497	(2002) Steel Welded Wire Reinforcement, Deformed, for Concrete
ASTM A 563	(2004a) Carbon and Alloy Steel Nuts
ASTM A 563M	(2004) Carbon and Alloy Steel Nuts (Metric)

ASTM A 615/A 615M	(2004b) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 616/A 616M	(1996a) Rail-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 617/A 617M	(1996a) Axle-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 653/A 653M	(2004a) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 706/A 706M	(2004b) Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM B 370	(2003) Copper Sheet and Strip for Building Construction
ASTM C 143	(1998) Slump of Hydraulic Cement Concrete
ASTM C 150	(2004a) Portland Cement
ASTM C 172	(2004) Sampling Freshly Mixed Concrete
ASTM C 185	(2002) Air Content of Hydraulic Cement Mortar
ASTM C 260	(2001) Air-Entraining Admixtures for Concrete
ASTM C 31/C 31M	(2003a) Making and Curing Concrete Test Specimens in the Field
ASTM C 33	(2003) Concrete Aggregates
ASTM C 39	(1993a) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 494	(1992) Chemical Admixtures for Concrete
ASTM C 59/C 59M5	(2000; Rev A) Blended Hydraulic Cements
ASTM C 59/C 59M5M	(1997) Blended Hydraulic Cements (Metric)
ASTM C 618	(2003) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
ASTM C 94	(1994) Ready-Mixed Concrete
ASTM C 989	(2004) Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars

PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

PCI MNL-116	(1999) Quality Control for Plants and Production of Structural Precast Concrete
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## Products

PCI MNL-117

(1996) Quality Control for Plants and  
Production of Architectural Precast  
Concrete Products

### 1.2 SUBMITTALS

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NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy projects.

Submittal items not designated with a "G" are considered as being for information only for Army projects and for Contractor Quality Control approval for Navy projects.

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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][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

Precast concrete wall panel; G, [\_\_\_\_\_]

#### SD-03 Product Data

Cast-in embedded items and connectors; G, [\_\_\_\_\_]

Connection devices; G, [\_\_\_\_\_]

#### SD-04 Samples

Concrete wall panel surface finishing; G, [\_\_\_\_\_]

#### SD-05 Design Data

Precast concrete wall panel design calculations; G, [\_\_\_\_\_]

Contractor-furnished mix design; G, [\_\_\_\_\_]

Concrete mix design for repair of surface defects; G, [\_\_\_\_\_]

Precast concrete wall panel connection and embedment design calculations; G, [\_\_\_\_\_]

#### SD-06 Test Reports

Strength tests; G, [\_\_\_\_\_]

Submit commercial testing results in accordance with PCI MNL-117 and as required in paragraph entitled "Sampling and Testing."

#### SD-08 Manufacturer's Instructions

Installation of precast concrete wall panel; G, [\_\_\_\_\_]

Cleaning of wall panel; G, [\_\_\_\_\_]

Include precast concrete wall panel manufacturer's written recommendations for installation and cleaning.

#### SD-11 Closeout Submittals

Concrete batch ticket information; G, [\_\_\_\_\_]

### 1.3 MODIFICATION OF REFERENCES

In the referenced ACI and PCI publications, consider the advisory provisions to be mandatory, as though the word "shall" had been substituted for the words "should" or "could" or "may," wherever they appear. Interpret reference to the "Building Official," the "Structural Engineer," and the "Architect/Engineer" to mean the Contracting Officer.

### 1.4 DELIVERY, STORAGE, AND HANDLING

Deliver packaged materials, except for wall panels, to the project site in the original, unbroken packages or containers, each bearing a label clearly identifying manufacturer's name, brand name, weight or volume, and other pertinent information. Store packaged materials, and materials in containers, in a weathertight and dry place until ready for use.

### 1.5 PLANT INSPECTION

[At the option of the Contracting Officer, precast units may be inspected.] [Precast units shall be inspected by the QC representative prior to being transported to the job site.] The Contractor shall give notice 14 days prior to the time the units will be available for plant inspection. Neither the exercise nor waiver of inspection at the plant will affect the

Government's right to enforce contractual provisions after units are transported or erected.

#### 1.5.1 PCI Quality Certifications

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NOTE: For normal routine projects, use the first paragraph. For complex or large precast/prestressed projects, use the second paragraph. Note that use of the second paragraph may limit competition. Verify the availability of certified PCI precasters in the bidding area. Do not use for LANTNAVFACENGCOM.  
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##### [1.5.1.1 Product Quality Control

PCI MNL-116 for PCI enrolled plants. Where panels are manufactured by specialist in plants not currently enrolled in the PCI "Quality Control Program," provide a product quality control system in accordance with PCI MNL-116 and perform concrete and aggregate quality control testing using an approved, independent commercial testing laboratory. Submit test results to the Contracting Officer.

##### ]1.5.1.2 Product Quality Control

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NOTE: Category C1: Mild steel reinforced precast concrete element. Category C2: Prestress hollow core and repetitive products. Category C3: Prestressed Straight Strand Structural Members. Category C4: Prestressed Draped Strand Structural Members.  
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Plants shall be certified by the PCI Plant Certification Program for Category [A1] [A2] work, or Architectural Precast Association (APA) certification.

#### ]1.6 QUALITY ASSURANCE

##### 1.6.1 Wall Panel Drawings

- a. Wall panel dimensions, cross-section, and edge details; location, size, and type of reinforcement, including reinforcement necessary for safe handling and erection of panels. Comply with ACI SP-66.
- b. Layout, dimensions, and identification of each panel, corresponding to installation sequence.
- c. Setting drawings, instructions, and directions for installation of concrete inserts.
- d. Location and details of anchorage devices and lifting devices embedded in panels, and connection details to building framing system.

### 1.6.2 Design Calculations

Submit design calculations prepared and sealed by a registered professional engineer demonstrating compliance with indicated loading conditions.

### 1.6.3 Connection and Embedment Design Calculations

Submit design calculations prepared and sealed by a professional engineer demonstrating compliance with the indicating connection and embedment details.

### 1.6.4 Mix Designs

Sixty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Include a complete list of materials including type; brand; source and amount of cement[, fly ash, pozzolan, ground slag,] and admixtures; and applicable reference specifications.

### 1.6.5 Concrete Wall Panel Surface Finish Sample

Submit a concrete wall panel sample 300 mm by 300 mm 12 inches by 12 inches by approximately 40 mm 1 1/2 inches in thickness, to illustrate quality, color, and texture of both exposed-to-view surface finish and finish of panel surfaces that will be concealed by other construction. [Obtain approval prior to submission of sample panels.]

### 1.6.6 Required Records

ASTM C 94. Submit mandatory batch ticket information for each load of ready-mixed concrete.

## PART 2 PRODUCTS

### 2.1 CONCRETE

#### 2.1.1 Contractor-Furnished Mix Design

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**NOTE: If gap-graded or one size architectural aggregates are used in a high coarse aggregate mix, delete the air percentage requirements and use the second bracketed sentence.**  
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ACI 211.1 and ACI 301. Concrete shall have a 28-day compressive strength of 28 MPa [4000] [\_\_\_\_\_] psi. [Air content of plastic concrete shall be between 4 and 6 percent air by volume.] [Provide a dosage of air entraining agent which will produce 19 plus or minus 3 percent air in a 1 to 4 by weight standard sand mortar in accordance ASTM C 185.]

#### [2.1.2 Exposed-to-View Facing Mixture

Provide aggregates for exposed-to-view facing mixture; white, gray, or buff portland cement or a blend of two or more portland cements; [air-entraining admixture;] and water. Provide exact proportions of facing mixture to produce concrete having the specified properties and capable of obtaining the approved surface color and finish.

### ]2.1.3 Backing Mixture

Provide the approved mix design.

## 2.2 MATERIALS

### 2.2.1 Fine Aggregates

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NOTE: Choose appropriate gradation based upon use  
of concrete. Where concrete is for back-up and  
separate facing aggregate is used, a gradation or  
maximum aggregate size may be specified.  
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ASTM C 33. The optional method of reducing the No. 50 and No. 100 sieve aggregates does not apply. The restriction to use only fine aggregates that do not contain any materials that are deleteriously reactive with alkalis in cement does apply.

### 2.2.2 Coarse Aggregate

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NOTE: Choose appropriate gradation based upon use  
of concrete. Where concrete is for back-up and  
separate facing aggregate is used, a gradation or  
maximum aggregate size may be specified. Class 5S  
is for exposed architectural concrete.  
\*\*\*\*\*

ASTM C 33, Size No. [57] [67], Class 5S. The restriction to use only coarse aggregates that do not contain any materials that are deleteriously reactive with alkalis in cement does apply. Aggregate shall not contain slag or crushed concrete.

### 2.2.3 Exposed Aggregate

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NOTE: Choose appropriate gradation based upon use  
of concrete. Where concrete is for back-up and  
separate facing aggregate is used, a gradation or  
maximum aggregate size may be specified.  
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In addition to the above, facing mixture aggregate, and aggregate for homogeneous panels with exposed aggregate finish, shall be [gravel] [crushed gravel] [crushed stone] of size and color to produce exposed surfaces to match the color and texture of the sample on file with the Contracting Officer.

### 2.2.4 Cement

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NOTE: Acceptable types of cement are:

ASTM C 150  
Portland

ASTM C 59/C 59M5M  
Blended

Type I

Type IP or IS

For general use in

59M5M	<u>ASTM C 150 Portland</u>	<u>ASTM C 59/C 59M5M Blended</u>	construction.
	Type II	Type IP (MS) or Type IS (MS)	For general use in construction where concrete is exposed to moderate sulfate action or where moderate heat of hydration is required. ASTM C 59/C
			(blended hydraulic cements): add the suffix MS or MH where either moderate sulfate resistance or moderate heat of hydration, respectively, is required.
	Type III	None	For use when high early strength is required.
	Type V	None	For use when high sulfate resistance is required.
59M5	<u>ASTM C 150 Portland</u>	<u>[ASTM C 59/C 59M5] Blended</u>	
	Type I	Type IP or IS	For general use in construction.
	Type II	Type IP (MS) or Type IS (MS)	For general use in construction where concrete is exposed to moderate sulfate action or where moderate heat of hydration is required. ASTM C 59/C
			(blended hydraulic cements): add the suffix MS or MH where either moderate sulfate resistance or moderate heat of hydration, respectively, is required.

ASTM C 150 <u>Portland</u> Type III	[ASTM C 59/C 59M5] <u>Blended</u> None	For use when high early strength is required.
Type V	None	For use when high sulfate resistance is required.

Specify either a tricalcium aluminate content of 5 percent maximum or 50 percent ground iron blast furnace slag with 50 percent portland cement or 25 percent pozzolan with 75 percent Type II portland cement when structure is within a saltwater spray range of 8 m 25 feet or within a horizontal distance of 30 m 100 feet. Require cement to meet chemical requirements of ASTM C 150, Table 1A, when using alkali-reactive aggregates.

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ASTM C 150, Type [I or II] [\_\_\_\_\_] [or ASTM C 59/C 59M5M ASTM C 59/C 59M5, Type [IP(MS) or IS(MS)] [\_\_\_\_\_] blended cement except as modified herein. The blended cement shall consist of a mixture of ASTM C 150 cement and one of the following materials: ASTM C 618 pozzolan or fly ash, or ASTM C 989 ground iron blast furnace slag. The pozzolan or fly ash content shall not exceed 25 percent, and ground slag shall not exceed 50 percent, by weight of the total cementitious material.] For exposed concrete, use one manufacturer for each type of cement[, pozzolan, fly ash, and ground slag].

#### 2.2.5 Fly Ash and Pozzolan

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NOTE: Fly ash and slag cement may produce uneven discoloration of the concrete during the early stages of construction, depending upon the type of curing provided. Fly ash or pozzolan meeting the specified test results, which are more stringent than ASTM C 618, should provide acceptable results, but it is recommended that fly ash, pozzolan, and ground slag not be permitted where appearance is an important factor. Fly ash or pozzolan should not be used in panels where light colored concrete is planned without first checking with the pigment manufacturer.

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ASTM C 618, Type N, F, or C, except that the maximum allowable loss on ignition shall be 6 percent for Type N and F. Add with cement.

#### 2.2.6 Ground Iron Blast-Furnace Slag

ASTM C 989, Grade 100 or 120.

#### 2.2.7 Admixtures

ASTM C 260 for air-entraining admixtures. Other admixtures: ASTM C 494. [Certify that admixtures are free of chlorides.]

#### 2.2.8 Water

Fresh, clean, and potable.

#### 2.2.9 Reinforcement

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NOTE: Specify ASTM A 775 for epoxy-coated reinforcing bars or ASTM A 767 and ASTM A 780 for zinc-coated (galvanized) bars. Define where coated bars are to be used, if not for entire project. Include ASTM publications in paragraph entitled "References":

A 767: Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement

A 775: Epoxy-Coated Reinforcing Bars

A 780: Repair of Damaged Hot-Dip Galvanized Coatings

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All exposed steel shall be phosphate treated, primed, and coated to prevent rust.

##### 2.2.9.1 Reinforcing Bars

ACI 301 unless otherwise specified. [ASTM A 706/A 706M, Grade [400] [60], ASTM A 615/A 615M, [400] [60], or ASTM A 617/A 617M, Grade [300] [40], or ASTM A 616/A 616M, Grade [400] [60].]

##### 2.2.9.2 Welded Wire Fabric

ASTM A 185 or ASTM A 497.

##### 2.2.9.3 Supports for Concrete Reinforcement

Include bolsters, chairs, spacers, and other devices necessary for proper spacing, supporting, and fastening in place.

- a. Supports: ASTM A 615/A 615M, wire-type reinforcing bars and welded wire fabric.
- b. Legs of supports in contact with formwork: Stainless steel, ASTM A 167, Type 302 or Type 304.

#### 2.3 Cast-In Embedded Items and Connectors

Structural embedded anchorage and connections to panels shall be designed to withstand gravity loads, live loads, dynamic loads, any volume change stresses inherent in the structure, and loads indicated.

##### 2.3.1 Inserts

###### 2.3.1.1 Threaded-Type Concrete Inserts

ASTM A 47/ASTM A 47, Grade 22010 Grade 32510 or 35018, or may be medium strength cast steel conforming to ASTM A 27/A 27M, Grade 415-205 Grade

U-60-30. Provide [galvanized] ferrous casting having enlarged base with two nailing lugs minimum length less than the thickness of panel less 20 mm 3/4 inch, and internally threaded to receive 20 mm 3/4 inch diameter machine bolt. Ferrous castings shall be ferritic malleable iron. [Provide inserts hot-dip galvanized after fabrication in accordance with ASTM A 153/A 153M.]

#### 2.3.1.2 Wedge-Type Concrete Inserts

Provide galvanized, box-type ferrous castings with integral anchor loop at back of box to accept 20 mm 3/4 inch diameter bolts having special wedge-shaped head. Provide ferrous castings[ ASTM A 47M, Grade 22010 ASTM A 47, Grade 32510 or 35018, ferritic malleable iron] [or] [ASTM A 27/A 27M, Grade 415-205, Grade U-60-30, medium-strength cast steel]. [Provide inserts hot-dip galvanized after fabrication in accordance with ASTM A 153/A 153M.]

#### 2.3.1.3 Slotted-Type Concrete Inserts

Provide pressed steel plate, welded construction, box type with slot to receive 20 mm 3/4 inch diameter square head bolt, and provide lateral adjustment of bolt. Length of insert body, less anchorage lugs, shall be 110 mm 4 1/2 inches minimum. Provide insert with knockout cover. Steel plate shall be 3 mm 1/8 inch minimum thickness, ASTM A 283/A 283M, Grade C. [Provide inserts hot-dip galvanized after fabrication in accordance with ASTM A 153/A 153M.]

#### 2.3.2 Embedded Plates

ASTM A 36/A 36M, [galvanized] ferrous metal plate connectors for attachment to the structural framing using manufacturer standard construction procedures. Headed studs shall use 400 MPa 60,000 psi steel with construction conforming to AWS D1.1/D1.1M, Type B. Deformed bar anchors shall conform to ASTM A 496. [Provide embedded anchors galvanized after fabrication in accordance with ASTM A 153/A 153M].

#### 2.3.3 Embedded Attachments

##### 2.3.3.1 Embedded Wood Nailer

Kiln-dried Standard Grade Douglas Fir or No. 2 Grade Southern Pine. Surface four sides. Treat with waterborne pressure-preservative in accordance with AWPA C1 and AWPA C2. All wood shall be air or kiln dried after treatment. Specific treatments shall be verified by the report of an approved independent inspection agency. The AWPA C1 and AWPA C2 Quality Mark "C1" and "C2" on each piece will be accepted, in lieu of inspection reports, as evidence of compliance with applicable AWPA treatment standards.

##### 2.3.3.2 Flashing Reglets

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NOTE: When visible staining from the flashing reglet can occur, chromium-nickel stainless steel should be specified. When the wall panels will be subjected to a coastal salt atmosphere, galvanized carbon steel flashing reglets should be used with care to prevent visible staining.  
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Fabricate of sheet metal, open-type with continuous groove 30 mm 1 1/8 inches deep minimum by 5 mm 3/16 inch wide at opening and sloped upward at 45 degrees. Top surface shall have toothed lip section to anchor upturned edge of metal snap-lock counter flashing when inserted. [Sheet metal shall be stainless steel, 0.28 mm 0.011 inch minimum thickness, ASTM A 167, Type 302 or Type 304, Number 2D finish, soft temper.] [Sheet metal shall be copper strip for building construction, weight 4.8 kg per square meter 16 ounce per square foot minimum, ASTM B 370, cold-rolled temper.] [Sheet metal shall be 0.5 mm 0.0179 inch minimum thickness (26 gage), galvanized carbon steel sheet, ASTM A 653/A 653M, Coating Designation Z275 G90.]

#### 2.3.4 Connection Devices

##### 2.3.4.1 Clip Angles

ASTM A 36/A 36M steel, galvanized after fabrication in accordance with ASTM A 153/A 153M.

##### 2.3.4.2 Ferrous Casting Clamps

ASTM A 47M, Grade 22010ASTM A 47, Grade 32510 or Grade 35018 malleable iron or cast steel, or ASTM A 27/A 27M, Grade 415-205 Grade U-60-30, cast steel casting, hot-dip galvanized in accordance with ASTM A 153/A 153M.

##### 2.3.4.3 Threaded Fasteners

Provide galvanized machine bolts, washers and, when required, nuts.

- a. Bolts: ASTM A 449, 20 mm 3/4 inch diameter machine bolts with hexagon head.
- b. Washers: ANSI B18.21.1, medium or heavy lock-spring washers.
- c. Nuts: ASTM A 563M ASTM A 563, Grade C, heavy, hexagon-type nuts.
- d. Square Nuts: ASTM A 563M ASTM A 563, Grade A, plain, square-type nuts where required for slotted-type concrete inserts.

#### 2.3.5 Form Materials

Provide forms and form-facing materials of wood, metal, plastic, or other approved material to produce concrete having the specified finish. Construct forms mortar-tight and of sufficient strength to withstand all pressures due to concrete placing operations and temperature changes within the specified fabrication tolerances.

#### 2.4 PANEL FABRICATION

##### 2.4.1 Formwork and Fabrication Tolerances

\*\*\*\*\*  
**NOTE: Review PCI MNL-117 and determine whether the tolerances specified are adequate for the project.**  
\*\*\*\*\*

Provide metal or wood forms. Brace and stiffen against deformation. Provide form liners where required to produce indicated finish. Provide dimensional tolerances as follows:

Overall panel dimensions:

3 m	Plus 3 mm
3 to 6 m	Plus or minus 3 mm
6 m	Plus or minus 5 mm

Thickness: Plus 6 mm, minus 3 mm

Angular deviation of sides:

Plus or minus one percent, 2 mm

Deviation from square (difference in length of two diagonals):

Not to exceed 0.1 percent, 6 mm

Size and location of openings within one unit:

Plus or minus 6 mm

Local smoothness (deviation from a true plane):

Plus or minus 0.2 percent

Bowing (convex or concave):

Length of bow/480 (0.2 percent), with a maximum of 15 mm

Position of reinforcement: Within 6 mm of indicated position

Position of anchorage devices: Plus or minus 12 mm

Position of pick-up devices: Plus or minus 75 mm

Overall panel dimensions:

10 feet or less	Plus 1/8 inch, minus zero
10 to 20 feet	Plus or minus 1/8 inch
20 feet or more	Plus or minus 3 1/6 inch

Thickness: Plus 1/4 inch, minus 1/8 inch

Angular deviation of sides:

Plus or minus one percent, 1/16 inch maximum

Deviation from square (difference in length of two diagonals):

Not to exceed 0.1 percent, 1/4 inch maximum

Size and location of openings within one unit:

Plus or minus 1/4 inch

Local smoothness (deviation from a true plane):

Plus or minus 0.2 percent

Bowing (convex or concave):

Length of bow/480 (0.2 percent), with a maximum of 5/8 inch

Position of reinforcement: Within 1/4 inch of indicated position

Position of anchorage devices: Plus or minus 1/2 inch

Position of pick-up devices: Plus or minus 3 inches

#### 2.4.2 Reinforcement

ACI 301. Place reinforcing bars and welded wire fabric. Secure in position with tie wires, bar supports, and spacers.

#### 2.4.3 Preparation for Placing Concrete

Remove hardened concrete, excess form parting compound, standing water, ice, snow, or other deleterious substances from form interiors and reinforcement before concrete placement. Secure reinforcement and embedded items.

#### 2.4.4 Concrete Mixing and Conveying

##### 2.4.4.1 Batch Plant, Mixer, Mixing, and Measuring of Materials

ASTM C 94.

##### 2.4.4.2 Conveying

Prevent segregation and loss of materials.

#### 2.4.5 Concrete Placing

ACI 304R. Deposit concrete in the forms continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the precast concrete wall panel. Place concrete at a constant temperature of between 10 and 32 degrees C 50 and 90 degrees F throughout fabrication of each panel. Make temperature of forms or molds the same as or close to the concrete temperature. For hot or cold weather, use methods recommended by ACI 305R and ACI 306.1. Vibrate and consolidate concrete to prevent segregation and to produce a high-density concrete free of honeycomb and rock pockets. When specified, the exposed-to-view facing mixture shall be a minimum thickness of 20 mm 3/4 inches. Place backing mixture before facing mixture attains initial set.

#### 2.4.6 Identification Markings

Permanently mark each panel to indicate pick-up points, location, orientation in the building, and date of casting. Identification markings shall correlate with approved detail drawings. Do not locate in exposed-to-view finished surfaces.

#### 2.4.7 Finishing

##### 2.4.7.1 Unformed Concealed Surfaces (Standard Smooth Finish)

Provide a trowel finish. Level surface with a straightedge, and strike off. After surface water has disappeared, float and trowel surface. Provide smooth finished surface, free of trowel marks, and uniform in texture and appearance.

##### 2.4.7.2 Smooth, Exposed-to-View Surfaces

Provide a standard smooth finish to all exposed-to-view surfaces of panels, unless otherwise indicated. Provide a concrete surface having the texture imparted by a steel form or other approved smooth surfaces form-facing material.

#### 2.4.7.3 Exposed Aggregate Finish

Provide for exposed-to-view surfaces of panels, including chamfers, edges, recesses, and projections, unless otherwise indicated. Provide standard smooth finish with outer skin of mortar removed, before concrete has hardened, and exposing coarse aggregate. A chemical retarder may be used on exposed face to facilitate removal of mortar. Match finish of the approved surface finish sample. Expose aggregates as soon after concrete placing as practicable [by wire brushing, sand blasting, or bush hammering] [or] [by washing the concrete surface with a diluted solution of muriatic acid to thoroughly clean exposed aggregate. Rinse concrete surface with fresh, clean water to remove traces of acid.]

#### 2.4.8 Curing

Provide moist or steam curing or curing compound. Do not remove panel from forms; prevent moisture loss and maintain 10 degrees C 50 degrees F minimum for at least 24 hours after finishing. Maintain panels in a surface damp condition at 10 degrees C 50 degree F minimum until concrete has attained 75 percent minimum of the design compressive strength. [Do not use steam curing with wood forms or in connection with chemically retarded exposed aggregate surfaces].

#### 2.4.9 Repair of Surface Defects

Cut out defective areas to solid concrete, with edges of cuts perpendicular to the surface of the concrete, and clean thoroughly. Dampen area to be patched and brush-coat with nonshrink grout or bonding agent. Patch the surface in accordance with procedures previously submitted by the Contractor and approved by the Contracting Officer. Where exposed to view, the patches, when dry, shall be indistinguishable from the surrounding surfaces.

##### 2.4.9.1 Smooth, Concealed Surfaces

Acceptable defective area shall be limited to holes left by rods and other temporary inserts, and to honeycomb or rock pockets of 6 mm 1/4 inch diameter maximum. Remove fins and other projections on the surfaces.

##### 2.4.9.2 Exposed-to-View Surfaces

The combined area of acceptable defective areas shall not exceed 0.2 percent of the exposed-to-view surface area and shall be limited to holes of 6 mm 1/4 inch diameter maximum.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Verify that all parts of the supporting structure are complete and ready to receive the panels and that site conditions are conducive to proper installation. Install precast concrete wall panels and accessories in accordance with approved detail drawings and descriptive data, and as specified below.

##### 3.1.1 Building Framing System

Provide supporting members, including anchorage items attached to or

embedded in building structural elements, prior to placement of panels.

### 3.1.2 Placing Panels

Panels shall attain the specified 28-day compressive design strength prior to placement. Provide temporary supports and bracing, as required, to maintain panel position and alignment during attachment to the building framing system. Secure adjustable connections after panels have been properly positioned. All welded connections shall conform to the requirements of AWS D1.1/D1.1M and AWS D1.4.

### 3.1.3 Erection Tolerances

\*\*\*\*\*  
**NOTE: Review PCI MNL-117 and determine whether the  
tolerances specified are adequate for the project.**  
\*\*\*\*\*

Locate panels to accommodate adjacent products, proper joint width, and alignment with adjacent precast members. Noncumulative dimensional tolerances for erection of panels are as follows:

a. Face width of joint

Panel dimension normal to joint

3 m 10 feet or under: Plus or minus 5 mm 3/16 in

3 m to 6 m 10 feet to 20 feet: Plus 5 mm minus 6 mm 3/16 inch minus  
1/4 inch

Each additional 3 m 10 feet: Plus or minus 2 mm 1/16 inch

b. Joint taper (panel edges not parallel): 0.2 percent or 2 mm 1/16  
inch total, whichever is larger, but not greater than 10 mm 3/8  
inch

c. Panel alignment

Jog in alignment of edge: 6 mm 1/4 inch

Offset in face of panel (exterior face unless otherwise noted): 6 mm  
1/4 inch

d. Variation from theoretical position, any location: Plus or minus  
6 mm 1/4 inch

e. Deviation from plumb: 0.2 percent, 10 mm 3/8 inch maximum

f. Maximum warpage after erection: One corner out of plane of other  
three, 0.5 percent of distance from nearer adjacent corner, or 3 mm  
1/8 inch

g. Differential bowing or camber of adjacent panels: 6 mm 1/4 inch  
maximum

### 3.1.4 Joints

Joint widths between panels shall be as specified unless otherwise

indicated. Provide joints with sealants in accordance with Section 07920 JOINT SEALANTS.

#### 3.1.5 Protection

Protect exposed-to-view facing from staining and other damage. Do not allow laitance to penetrate, stain, or harden on exposed surfaces.

#### 3.2 CLEANING

Clean exposed-to-view surfaces of panels thoroughly with detergent and water; use a brush to remove foreign matter. Remove stains that remain after washing in accordance with recommendations of the panel manufacturer. Surfaces shall be clean and uniform in color.

#### 3.3 SAMPLING AND TESTING

##### 3.3.1 Product Quality Control

PCI MNL-117 for PCI enrolled plants. Where panels are manufactured by specialists in plants not currently enrolled in the PCI "Quality Control Program," provide a product quality control system in accordance with PCI MNL-117 and perform concrete and aggregate quality control testing using an approved, independent commercial testing laboratory. Submit test results to the Contracting Officer.

##### 3.3.1.1 Aggregate Tests

ASTM C 33. Perform one test for each aggregate size, including determination of the specific gravity.

##### 3.3.1.2 Strength Tests

ASTM C 172. Provide ASTM C 39 and ASTM C 31/C 31M compression tests. Perform ASTM C 143 slump tests. Mold six cylinders each day or for every 15 cubic meters 20 cubic yards of concrete placed, whichever is greater. Perform strength tests using two cylinders at 7 days and two at 28 days. Cure four cylinders in the same manner as the panels and place at the point where the poorest curing conditions are offered. Moist cure two cylinders and test at 28 days.

##### 3.3.1.3 Changes in Proportions

If, the compressive strength falls below that specified, adjust the mix proportions and water content and make necessary changes in the temperature, moisture, and curing procedures to secure the specified strength. Notify the Contracting Officer of all changes.

##### 3.3.1.4 Strength Test Results

Evaluate compression test results at 28 days in accordance with ACI 214R using a coefficient of variation of 20 percent. Evaluate the strength of concrete by averaging the test results (two specimens) of standard cylinders tested at 28 days. Not more than 20 percent of the individual tests shall have an average compressive strength less than the specified ultimate compressive strength.

### 3.3.2 Rejection

Panels in place may be rejected for any one of the following product defects or installation deficiencies remaining after repairs and cleaning have been accomplished. "Visible" means visible to a person with normal eyesight when viewed from a distance of 6 m 20 feet in broad daylight.

- a. Nonconformance to specified tolerances.
- b. Air voids (bugholes or blowholes) larger than 10 mm<sup>3</sup>/8 inch diameter.
- c. Visible casting lines.
- d. Visible from joints.
- e. Visible irregularities.
- f. Visible stains on panel surfaces.
- g. Visible differences between panel and approved sample.
- h. Visible nonuniformity of textures or color.
- i. Visible areas of backup concrete bleeding through the facing concrete.
- j. Visible foreign material embedded in the face.
- k. Visible repairs.
- l. Visible reinforcement shadow lines.
- m. Visible cracks.

### 3.3.3 Field Quality Control

Perform field inspection of panel connections. The Contracting Officer shall be notified in writing of defective welds, bolts, nuts and washers within 7 working days of the date of inspection. All defective connections or welds shall be removed and re-welded or repaired as required by the Contracting Officer.

#### 3.3.3.1 Welded Connection Visual Inspection

AWS D1.1/D1.1M, furnish the services of AWS-certified welding inspector for erection inspections. Welding inspector shall visually inspect all welds and identify all defective welds.

-- End of Section --