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USACE / NAVFAC / AFCEC / NASA **UFGS-03 45 33 (May 2016)**

Preparing Activity: NAVFAC **Superseding**
UFGS-03 45 33 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
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DIVISION 03 - CONCRETE

SECTION 03 45 33

PRECAST[PRESTRESSED] STRUCTURAL CONCRETE

05/16

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SECTION 03 45 33

PRECAST[PRESTRESSED] STRUCTURAL CONCRETE
05/16

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NOTE: This guide specification covers the requirements for precast non-prestressed and precast prestressed concrete used for structural purposes (floor units, roof units, joists, beams, planks, columns, single- and double-tee slabs, hollow-cored flat slabs, tee- or keystone-joists, and other structural framing elements, etc.) and for minor architectural purposes (copings, window sills, etc.) in building and waterfront facilities construction.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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NOTE: This guide specification does not cover precast concrete wall panels (Section 03 45 00 PRECAST ARCHITECTURAL CONCRETE), major precast non-prestressed architectural concrete, post tensioned concrete, or precast concrete which is site manufactured and must not be used for bridge or roadway construction. Precast concrete sound fences should be considered in lieu of block walls for use where sound barriers are used for noise abatement.

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NOTE: The following information must be shown on

the project drawings:

1. Live and dead loads, and whether the topping is included in the dead load.

2. Details of fitting, bearing, and connections.

3. Location of expansion and control joints.

4. Layout of the framing system indicating the relative location of the various precast structural concrete sections, floor elevations, column centers and offsets, openings, and sufficient dimensions to adequately convey the quantity and nature of the required precast structural concrete framing system.

5. Details of all precast structural concrete sections indicating cross-sections and dimensions.

6. Location of precast structural concrete sections having an architectural finish on exposed-to-view surfaces when required.

7. Details of openings including the size of steel framing members as required.

8. Style and area of steel welded wire reinforcement in areas where required. Kind and size of reinforcing bars and spacing.

9. Strength and type of concrete.

10. Detail of placement of sealant or fillers in joints.

11. Fire rating.

12. Lightweight concrete unit weight.

13. Special requirements for concrete cover over reinforcing.

14. Areas where toppings are required, indicate areas where the full thickness of the topping is not present.

15. Camber.

16. Tendon types, physical properties, and allowable design stresses.

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PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide

specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO LRFDCONS	(3rd Edition; 2010, 2011, 2012, 2014, 2015, and 2016 Int) Bridge Construction Specifications
AASHTO M 251	(2006; R 2011) Standard Specification for Plain and Laminated Elastomeric Bridge Bearings
AASHTO T 259	(2002; R 2017) Standard Method of Test for Resistance of Concrete to Chloride Ion Penetration

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 318	(2014; Errata 1-2 2014; Errata 3-5 2015; Errata 6 2016; Errata 7-9 2017) Building Code Requirements for Structural Concrete (ACI 318-14) and Commentary (ACI 318R-14)
ACI 318M	(2014; ERTA 2015) Building Code Requirements for Structural Concrete & Commentary

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA A135.4	(1995; R 2004) Basic Hardboard

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020) Structural Welding Code - Steel
AWS D1.4/D1.4M	(2011) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2018; E 2018) Standard Specification for Ferritic Malleable Iron Castings
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2016a) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A325M	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Minimum Tensile Strength (Metric)
ASTM A416/A416M	(2018) Standard Specification for Low-Relaxation, Seven-Wire for Prestressed Concrete
ASTM A421/A421M	(2015) Standard Specification for Uncoated Stress-Relieved Steel Wire for Prestressed Concrete
ASTM A563	(2015) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A615/A615M	(2020) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A706/A706M	(2016) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A722/A722M	(2015) Standard Specification for Uncoated High-Strength Steel Bar for Prestressing Concrete
ASTM A767/A767M	(2016) Standard Specification for

	Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
ASTM A775/A775M	(2017) Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A934/A934M	(2016) Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
ASTM A996/A996M	(2016) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM A1064/A1064M	(2017) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C33/C33M	(2018) Standard Specification for Concrete Aggregates
ASTM C94/C94M	(2020) Standard Specification for Ready-Mixed Concrete
ASTM C150/C150M	(2020) Standard Specification for Portland Cement
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C295/C295M	(2019) Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C311/C311M	(2018) Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
ASTM C330/C330M	(2017a) Standard Specification for Lightweight Aggregates for Structural Concrete
ASTM C494/C494M	(2019) Standard Specification for Chemical Admixtures for Concrete
ASTM C618	(2019) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C989/C989M	(2018a) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

ASTM C1202	(2019) Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
ASTM C1218/C1218M	(2020c) Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
ASTM C1240	(2020) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C1260	(2014) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	(2013) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602/C1602M	(2018) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D5759	(2012; R 2020) Characterization of Coal Fly Ash and Clean Coal Combustion Fly Ash for Potential Uses
ASTM F436	(2011) Hardened Steel Washers
ASTM F436M	(2011) Hardened Steel Washers (Metric)
ASTM F844	(2007a; R 2013) Washers, Steel, Plain (Flat), Unhardened for General Use

PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

PCI MNL-116	(1999) Manual for Quality Control for Plants and Production of Structural Precast Concrete Products, 4th Edition
PCI MNL-120	(2010) PCI Design Handbook - Precast and Prestressed Concrete, 6th Edition
PCI MNL-124	(2011) Design for Fire Resistance of Precast Prestressed Concrete, Third Edition
PCI MNL-135	(2000) Tolerance Manual for Precast and Prestressed Concrete Construction

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-C-882	(1989; Rev E) Cloth, Duck, Cotton or Cotton-Polyester Blend, Synthetic Rubber, Impregnated, and Laminated, Oil Resistant

UNDERWRITERS LABORATORIES (UL)

UL Fire Resistance (2014) Fire Resistance Directory

1.2 MODIFICATION TO REFERENCE

In the ACI publications, reference to the "Building Official," the "Structural Engineer" and the "Architect/Engineer" must be interpreted to mean the Contracting Officer.

1.3 SUBMITTALS

****
NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters 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, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force, and NASA projects, or choose the second bracketed item for Army projects.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings of Precast Members; G[, [_____]]

Drawings of Precast Prestressed Concrete Members; G[, [_____]]

SD-03 Product Data

Anchorage and Lifting Inserts and devices

Bearing Pads

SD-04 Samples

[Surface Finish

] SD-05 Design Data

[Precast][Prestressed] Concrete Members Design Calculations; G[, [_____]]

Concrete Mix Design; G[, [_____]]

SD-06 Test Reports

Concrete Mix Design; G[, [_____]]

Fly Ash

Pozzolan

[Ground Granulated Blast-Furnace Slag

][Aggregates

][Concrete and Aggregate Quality Control Testing

][Water

] SD-07 Certificates

Quality Control Procedures

[Construction Records; G[, [_____]]

][Epoxy-Coated Steel Bars

][Erector's Post Audit Declaration

] SD-11 Closeout Submittals

Concrete Batch Ticket Information

Recycled Content for Fly Ash and Pozzolan; S

Recycled Content for Ground Iron Blast-Furnace Slag; S

Recycled Content for Silica Fume

1.4 QUALITY ASSURANCE

1.4.1 Qualifications

1.4.1.1 Manufacturer Qualifications

****

NOTE: Use first bracketed paragraph unless no PCI certified plant are available. Then select the second paragraph.

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 Deflected Strand Structural Members.

****

[PCI MNL-116. Plants must be certified by the PCI Plant Certification Program for Category [C1] [C2] [C3] [C4] work. At the Contracting Officer's option, PCI Plant quality control program records must be available for review.

][PCI MNL-116. 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-116 and perform concrete and aggregate quality control testing using an approved, independent commercial testing laboratory. Submit test results to the Contracting Officer.

]1.4.1.2 Erector Certification

****

NOTE: Use Category S1 for horizontal decking members such as hollow core slabs. Use Category S2 for total precast concrete systems, vertical and horizontal load bearing members, and single- or multistory loadbearing members, including those with architectural finishes.

****

Erector with erecting organization and all erecting crews certified and designated by PCI's Certificate of Compliance to erect Category[S1 (Simple Structural Systems)][S2 (Complex Structural Systems)].

[1.4.1.3 Erector Qualifications

****

NOTE: Use the following paragraph when a PCI Certified erector is not available in the project location.

****

A precast erector that is not certified by PCI must retain a PCI-Certified Field Auditor, at the erector's expense, to conduct a field audit of a project in the same category as this project prior to start of precast concrete erection and must submit the Erector's Post Audit Declaration to be considered qualified.

]1.4.1.4 Welding Qualifications

Provide AWS D1.1/D1.1M qualified welders who are currently certified at contract award date and have maintained their certificates over the past year.

1.4.2 Regulatory Requirements

****
NOTE: Modify to add any local codes and regulations.
****

Provide precast [prestressed] members in conformance with ACI 318M ACI 318 and PCI MNL-120.

1.4.3 Concrete Mix Design

****
NOTE: Normal precast design is based on concrete having a compressive strength of 35 MPa 5000 psi at 28 days. Some precast manufacturers like to speed up production by using Type III (high early strength) concrete. For marine exposure, (or moderate and severe sulfate exposure) include last bracketed sentence, which limits the water-cement ratio to a maximum of 0.40.
****

****
NOTE: Delete air entraining requirements when the project is located in a nonfreezing climate.
****

ACI 318MACI 318. The minimum compressive strength of concrete at [28] [_____] days must be 35 MPa 5000 psi [_____], unless otherwise indicated.[Add air-entraining admixtures at the mixer to produce between 4 and 6 percent air by volume.][For marine exposure, ensure a dense concrete free of shrinkage cracks, with a minimum degree of permeability. The maximum water cement ratio must be 0.40].

Sixty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Submit a complete list of materials including type; brand; source and amount of cement, complementary cementitious materials, [polypropylene fibers], and admixtures; and applicable reference specifications. Submit mill test and all other test for cement, complementary cementitious materials, aggregates, and admixtures. Provide documentation of maximum nominal aggregate size, gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size. Provide mix proportion data using at least three different water-cementitious material ratios for each type of mixture, which produce a range of strength encompassing those required for each type of concrete required. If source material changes, resubmit mix proportion data using revised source material. Provide only materials that have been proven by trial mix studies to meet the requirements of this specification, unless otherwise approved in writing by the Contracting Officer. Indicate clearly in the submittal where each mix design is used when more than one mix design is submitted. Resubmit data on concrete components if the qualities or source of components changes. For previously approved concrete mix designs used within the past twelve months, the previous mix design may be re-submitted without further trial

batch testing if accompanied by material test data conducted within the last six months. Obtain mix design approval from the contracting officer prior to concrete placement.

1.4.4 Certificates: Record Requirement

ASTM C94/C94M. Submit mandatory batch ticket information for each load of ready-mixed concrete.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Transportation

1.5.1.1 Transporting Members

Transport members in a manner to avoid excessive stresses that could cause cracking or other damage.

1.5.1.2 Lateral Deflection or Vibration

Any noticeable indication of lateral deflection or vibration during transportation must be corrected by rigid bracing between members or by means of lateral trussing.

1.5.2 Storage

1.5.2.1 Storage Areas

Storage areas for precast [prestressed] members must be stabilized, and suitable foundations must be provided, so differential settlement or twisting of members will not occur.

1.5.2.2 Stacked Members

Stack members with adequate dunnage and bracing to control cracking, distortion, warping or other physical damage. Stack members such that lifting devices will be accessible and undamaged.

1.5.3 Handling of Members

The location of pickup points for handling of the members and details of the pickup devices must be shown in shop drawings. Members must be handled only by means of approved devices at designated locations. Members must be maintained in an upright position at all times and picked up and supported as shown in approved shop drawings.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

The work includes the provision of precast[non-prestressed concrete herein referred to as precast members][and][precast, prestressed concrete herein referred to as prestressed members][except that precast concrete wall panels must be provided as specified in Section 03 45 00 PRECAST ARCHITECTURAL CONCRETE]. [Precast][and][Prestressed] members must be the product of a manufacturer specializing in the production of precast [prestressed] concrete members.

****

NOTE: When concrete toppings are indicated, they are normally allowed to be used in establishing the design strength of the precast [prestressed] member. However, areas where the topping is not the full thickness, and areas without topping located inside of larger areas with topping need to be indicated so that the topping is not used in the untopped areas to establish the design strength of the precast [prestressed] members.

****

2.1.1 Design Requirements

Design precast [prestressed]members in accordance with ACI 318M ACI 318 and the PCI MNL-120. Design precast [prestressed] members (including connections) for the design load conditions and spans indicated, and handling and erection stresses, and for additional loads imposed by openings and supports of the work of other trades. Design precast[prestressed] members for handling without cracking in accordance with the PCI MNL-120. [Concrete toppings must [not] be used in establishing the design strength of the precast[prestressed] members.]

****

NOTE: Evaluate the loading requirements for the member design including all dead and live loads, and other specified loads for member, where applicable. Show design loads on the drawings. The designer of the precast [prestressed] members should also consider the effects of initial handling and erection stress in the final design of the elements.

****

2.1.1.1 Loads

Loadings for members and connections must include all dead load, live load, applicable lateral loads such as wind and earthquake, applicable construction loads such as handling, erection loads, and other applicable loads.

2.1.1.2 Drawing and Design Calculation Information

****

NOTE: Modify requirements based on the scope of the project.

****

Submit drawings and design calculations indicating complete information for the fabrication, handling, and erection of the precast[prestressed] member. Include a cover page with the design calculations, signed and sealed by the registered design professional who prepared the design. Drawings must not be reproductions of contract drawings. Design calculations[, drawings of precast members][[, and]drawings of precast prestressed concrete members] (including connections) must be made by a registered professional engineer experienced in the design of precast [prestressed]concrete members, and submitted for approval prior to fabrication. The drawings must indicate, as a minimum, the following information:

a. Plans, elevations and other drawing views showing the following:

(1) Member piece marks locating and defining products furnished by the manufacturer.

(2) Headers for openings.

(3) Location and size of openings [that cut prestressing strands or require the location of prestressing strands to miss field cut openings].

(4) Relationships to adjacent material.

(5) Joints and openings between members and between members and other construction.

(6) Location of field installed anchors.

(7) Erection sequences and handling requirements

[(8) Areas receiving toppings and magnitude of topping thickness. Identify areas where topping is an integral part of the structural capacity of the precast members.

] (9) Lifting and erection inserts

b. Elevations, sections and other details for each member showing the following:

(1) Connections between members and connections between members and other construction.

(2) Connections for work of other trades and cast-in items and their relation to other trades.

(3) Dimensioned size and shape for each member with quantities, position and other details of reinforcing steel, anchors, inserts and other embedded items.

(4) Lifting, erection and other handling devices and inserts.

(5) Surface finishes of each member.

(6) Estimated cambers

[c. Magnitude, schedule and sequence of tensioning and detensioning prestressing strands.

] d. Strength properties for concrete, steel and other materials.

e. Methods for storage and transportation.

f. Description of loose, cast-in and field hardware.

g. All dead, live, handling, erection and other applicable loads used in the design.

h. Signature and seal of the registered design professional who prepared the design.

2.1.2 Performance Requirements

****

NOTE: Edit when precast [prestressed] members are to be fire rated. On most large jobs, not all members will have the same fire rating, so fire ratings for each specific member should be indicated for clarity.

****

Precast[prestressed] members [where indicated] must have a fire rating [of [_____]-hours] [as indicated] in accordance with UL Fire Resistance, or as designed in accordance with PCI MNL-124.

2.2 MATERIALS

2.2.1 Material Sustainability Criteria

For products in this section, where applicable and to extent allowed by performance criteria, provide and document the following in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING:

a. Recycled content for fly ash and pozzolan
b. Recycled content for Ground Iron Blast-Furnace Slag
c. Recycled content for Silica Fume

2.2.2 Cementitious Materials

****

NOTE: Acceptable types of cement are as follows:

ASTM C150/C150M Portland	**ASTM C595/C595M Blended**	**Use**
Type I	**Type IP or IS**	**For general use in contruction**

ASTM C150/C150M Portland	ASTM C595/C595M Blended	Use
Type II	Type IP (MH) or Type IS (MH)	For general use in construction where concrete is exposed to moderate sulfate action or where moderate heat of hydration is required. ASTM C595/C595M (blended hydraulic cements): add the suffix MS or MH where either moderate sulfate resistance or moderate heat of hydration, respectively, is required. Type IP is portland-pozzolan blended cement and Type IS is portland-blast furnace slag cement.
	Type IP (MH) or Type IS (MH)	For general use in construction where Concrete is exposed to moderate heat of hydration.
Type III	None	For use when high early strength is required. Confer with the agency's Subject Matter Expert in Concrete Materials before specifying Type III cement.
Type V	None	For use when high sulfate resistance is required.

For concrete subjected to salt water, near salt water or exposed to alkali/sulfate soils refer to specification Section 03 31 30 MARINE CONCRETE for additional criteria.

****

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NOTE: For NAVFAC LANT: Typically allow Type II, IP (MS), or IS (MS). May use Type I if Type II not locally available and no sulfate problems expected (i.e. not near seawater or sulfate soils). Type III is for high early strength. Type V is for high sulfate resistance.

****

****

NOTE: Coal fly ash, slag, cenospheres, and silica fumes are EPA designated products to be ingredients in concrete and cement. See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING and include additive options unless designer determines that justification for non-use exists.

****

For exposed concrete, use one manufacturer and one source for each type of cement, ground slag, fly ash, and pozzolan.

2.2.2.1 Fly Ash

****

NOTE: Fly ash, pozzolan, 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 C618, should provide acceptable end results. It is suggested that fly ash be used as a replacement for 35 percent of the cement. Class C fly ash is not permitted.

****

ASTM C618, Class F, except that the maximum allowable loss on ignition must not exceed [3][6] percent. Class F fly ash for use in mitigating Alkali-Silica Reactivity must have a Calcium Oxide (CaO) content of less than 8 percent and a total equivalent alkali content less than 1.5 percent.

Add with cement. Fly ash content must be a minimum of [15][20][30][35][40][_____] percent by weight of cementitious material, provided the fly ash does not reduce the amount of cement in the concrete mix below the minimum requirements of local building codes. Where the use of fly ash cannot meet the minimum level, provide the maximum amount of fly ash permittable that meets the code requirements for cement content. Report the chemical analysis of the fly ash in accordance with ASTM C311/C311M. Evaluate and classify fly ash in accordance with ASTM D5759.

2.2.2.2 Raw or Calcined Natural Pozzolan

Natural pozzolan must be raw or calcined and conform to ASTM C618, Class N, including the optional requirements for uniformity and effectiveness in controlling Alkali-Silica reaction and must have an ignition loss not exceeding 3 percent. Class N pozzolan for use in mitigating Alkali-Silica Reactivity must have a Calcium Oxide (CaO) content of less than 13 percent and total equivalent alkali content less than 3 percent.

2.2.2.3 Ultra Fine Fly Ash and Ultra Fine Pozzolan

Ultra Fine Fly Ash (UFFA) and Ultra Fine Pozzolan (UFP) must conform to ASTM C618, Class F or N, and the following additional requirements:

a. The strength activity index at 28 days of age must be at least 95 percent of the control specimens.

b. The average particle size must not exceed 6 microns.

c. The sum of SiO_2 + Al_2O_3 + Fe_2O_3 must be greater than 77 percent.

2.2.2.4 Ground Granulated Blast-Furnace Slag

ASTM C989/C989M, Grade [100][120]. Slag content must be a minimum of [25][50][70] percent by weight of cementitious material.

[2.2.2.5 Silica Fume

****
NOTE: Silica Fume must only be used for OCONUS projects where Class F fly ash and GGBF slag are not available, and when approved by the Contracting Officer. Guidance for use of silica fume should be sought from the agency's Subject Matter Expert in Concrete Materials.
****

****
NOTE: The initial cost of the concrete must increase, and supervision at the batch plant, finishing, and curing is necessary. A HRWR must be used with silica fume, the slump can be increased 50 to 125 mm 2 to 5 inches without reducing strength. Finishing may be more difficult. Proper curing is essential because there is a tendency for plastic shrinkage cracking.
****

Silica fume must conform to ASTM C1240, including the optional limits on reactivity with cement alkalis. Silica fume may be furnished as a dry, densified material or as slurry. Proper mixing is essential to accomplish proper distribution of the silica fume and avoid agglomerated silica fume which can react with the alkali in the cement resulting in premature and extensive concrete damage. Supervision at the batch plant, finishing, and curing is essential. Provide at the Contractor's expense the services of a manufacturer's technical representative, experienced in mixing, proportioning, placement procedures, and curing of concrete containing silica fume. This representative must be present on the project prior to and during at least the first 4 days of concrete production and placement using silica fume. A High Range Water Reducer (HRWR) must be used with silica fume.

]2.2.2.6 Portland Cement

****
NOTE: If high early strength concrete is required, specify Type III after consulting the agency's Subject Matter Expert in Concrete Materials.

When concrete is exposed to sea water use specification Section 03 31 30 MARINE CONCRETE.

When high-volume fly ash mixtures, mixtures where fly ash replacement of portland cement is greater than 50 percent by weight, are specified they may be blended with Type II or Type III cement for higher

early strength. Consult the agency's Subject Matter Expert in Concrete Materials prior to using Type III cement.

Low alkali cement or Type II cement with high SCM content may be required if the proposed aggregates are found to be expansive.

****

Provide cement that conforms to ASTM C150/C150M, Type [I][II][III], [low alkali] [including false set requirements] with tri-calcium aluminates (C3A) content less than 10 percent and a maximum cement-alkali content of 0.80 percent Na2Oe (sodium oxide) equivalent. Use one brand and type of cement for formed concrete having exposed-to-view finished surfaces.

[For portland cement manufactured in a kiln fueled by hazardous waste, maintain a record of source for each batch.][Supplier must certify that no hazardous waste is used in the fuel mix or raw materials.][Supplier must certify that the hazardous waste is neutralized by the manufacturing process and that no additional pollutants are discharged.]

2.2.3 Water

Water must comply with the requirements of ASTM C1602/C1602M. Minimize the amount of water in the mix. Improve workability by adjusting the grading rather than by adding water. Water must be [potable][from rainwater collection][from graywater][from recycled water]; free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete. Submit test report showing water complies with ASTM C1602/C1602M.

2.2.4 Aggregates

****

NOTE: Include the first bracketed item on large concrete projects, where concrete is exposed to moist conditions, or the quality of the aggregates is questionable, or when the use of alkali-reactive aggregates is permitted.

When the use of alkali-reactive aggregates is permitted, add the following in front of the first bracket, and add the paragraph entitled "Additional Curing When Using Alkali-Reactive Aggregates" as follows:

"Alkali-reactive aggregates may be used with one of the following cements:

1. ASTM C150/C150M low alkali cement (Table 1A, maximum of 0.60 percent equivalent Na2O).

2. ASTM C595/C595M blended cement.

3. ASTM C150 low alkali, Type I or II cement with fly ash, pozzolan, or grong slag.

Furnish a mix design utilizing alkali-reactive aggregates with a maximum water-cementitious

material ratio of 0.45. Aggregates must meet the following requirements".

When using Alkali-Reactive Aggregates, follow curing requirements detailed in the Note in the section entitled, "Curing and Protection".

****

ASTM C33/C33M, except as modified herein. Furnish aggregates for exposed concrete surfaces from one source. Provide aggregates that do not contain any substance which may be deleteriously reactive with the alkalies in the cement. Submit test report showing compliance with ASTM C33/C33M.

[Fine and coarse aggregates must show expansions less than 0.08 percent at 28 days after casting when testing in accordance with ASTM C1260. Should the test data indicate an expansion of 0.08 percent or greater, reject the aggregate(s) or perform additional testing using ASTM C1567 using the Contractor's proposed mix design. In this case, include the mix design low alkali portland cement and one of the following supplementary cementitious materials:

a. GGBF slag at a minimum of 40 percent of total cementitious

b. Fly ash or natural pozzolan at a minimum of total cementitious of

(1) 30 percent if (SiO_2 plus Al_2O_3 plus Fe_2O_3) is 65 percent or more,
(2) 25 percent if (SiO_2 plus Al_2O_3 plus Fe_2O_3) is 70 percent or more,
(3) 20 percent if (SiO_2 plus Al_2O_3 plus Fe_2O_3) is 80 percent or more,
(4) 15 percent if (SiO_2 plus Al_2O_3 plus Fe_2O_3) is 90 percent or more.

[c. Silica fume at a minimum of 7 percent of total cementitious.

] If a combination of these materials is chosen, the minimum amount must be a linear combination of the minimum amounts above. Include these materials in sufficient proportion to show less than 0.08 percent expansion at 28 days after casting when tested in accordance with ASTM C1567.

Aggregates must not possess properties or constituents that are known to have specific unfavorable effects in concrete when tested in accordance with ASTM C295/C295M.

][2.2.4.1 Aggregates for Lightweight Concrete

ASTM C330/C330M.

]2.2.5 Grout

2.2.5.1 Nonshrink Grout

ASTM C1107/C1107M.

2.2.5.2 Cementitious Grout

****

NOTE: Delete air entraining requirements when the project is located in a nonfreezing climate.

****

Must be a mixture of portland cement, sand, and water. Proportion one part cement to approximately 2.5 parts sand, with the amount of water based on placement method.[Provide air entrainment for grout exposed to the weather.]

2.2.6 Admixtures

[2.2.6.1 Air-Entraining

****
NOTE: Delete air entraining requirements when the project is located in a nonfreezing climate.
****

ASTM C260/C260M.

]2.2.6.2 Accelerating

ASTM C494/C494M, Type C or E.

2.2.6.3 Water Reducing

ASTM C494/C494M, Type A, E, or F.

2.2.7 Reinforcement

2.2.7.1 Reinforcing Bars

****
NOTE: Specify ASTM A706/A706M reinforcing where welding or bending of reinforcement bars is important. In addition in locations where reinforcing maybe subject to corrosive environmental conditions such as bridge decking use either epoxy coated reinforcement, epoxy coated prefabricated steel reinforcing bars or zinc-coated (galvanized) bars, ASTM A775/A775M epoxy coated reinforcing, ASTM A934/A934M epoxy coated prefabricated steel reinforcing bars or ASTM A767/A767M respectively may be specified where extra reinforcement protection is required.
****

ASTM A615/A615M, Grade [280] [420] [40] [60]; [ASTM A706/A706M, Grade 420 60;] or ASTM A996/A996M, Grade [350][420] [50] [60].

[Epoxy-coated steel bars must comply with the requirements of [ASTM A775/A775M][ASTM A934/A934M], including written certifications for coating material and coated bars, sample of coating material, and 700 g 0.5 pounds of patching material. Submit written certification with the delivery of the bars.

][Zinc-coated (galvanized) bars must comply with the requirements of ASTM A767/A767M, Class II coating, galvanized after fabrication.

]2.2.7.2 Wire

ASTM A1064/A1064M.

2.2.7.3 Welded Wire Reinforcement

ASTM A1064/A1064M.

2.2.7.4 Supports for Concrete Reinforcement

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

Ensure legs of supports in contact with formwork for sections that will be exposed to weather are hot-dip galvanized after fabrication, plastic coated, or corrosion-resistant steel bar supports.

[2.2.8 Prestressing Strands

[Uncoated, 7-wire strand stress- relieved, ASTM A416/A416M, Grade 1725 250 1860 270, strand diameter as shown.

][Single wire stress- relieved, ASTM A421/A421M for low relaxation wire.

][High-strength steel bars must conform to ASTM A722/A722M, Type I or II, meeting all supplementary requirements.

]]2.2.9 Metal Accessories

Provide ASTM A123/A123M or ASTM A153/A153M galvanized.

2.2.9.1 Inserts

ASTM A47/A47M, Grade 22010 32510, or ASTM A27/A27M Grade 415-205 60-30. Submit product data.

2.2.9.2 Structural Steel

ASTM A36/A36M.

2.2.9.3 Bolts

ASTM A307; ASTM A325M ASTM A325.

2.2.9.4 Nuts

ASTM A563MASTM A563.

2.2.9.5 Washers

ASTM F844 washers for ASTM A307 bolts, and ASTM F436M ASTM F436 washers for ASTM A325M ASTM A325bolts.

2.2.10 Bearing Pads

Submit product data for all bearing pads being used.

2.2.10.1 Elastomeric

AASHTO M 251, for plain neoprene bearings.

2.2.10.2 Hardboard (Interior Only)

AHA A135.4, class as specified by the precast manufacturer.

2.2.10.3 Random-Oriented, Fiber-Reinforced Elastomeric Pads

Preformed, randomly oriented synthetic fibers set in elastomer. Surface hardness of 70 to 90 Shore A durometer according to ASTM D2240. Capable of supporting a compressive stress of 20.7 Mpa 3000 psi with no cracking, splitting or delaminating in the internal portion of the pad.

2.2.10.4 Cotton-Duck-Fabric-Reinforced Elastomeric Pads

Preformed, horizontally layered cotton-duck fabric bonded to an elastomer. Surface hardness of 80 to 100 Shore A durometer according to ASTM D2240. Conforming to Division II, Section 18.10.2 of AASHTO LRFDCONS Bridge Design Specifications or Military Specification MIL-C-882.

2.2.10.5 Frictionless Pads

Polytetrafluoroethylene (PTFE), glass-fiber reinforced, bonded to stainless or mild-steel plates, or random-oriented, fiber-reinforced elastomeric pads, of type required for in-service stress.

2.2.10.6 High-Density Plastic

Multimonomer, nonleaching, plastic strip capable of supporting loads with no visible overall expansion.

2.3 PRODUCTION QUALITY CONTROL PROCEDURES

****
NOTE: Refer to PCI for tolerance information. Modify to add critical tolerance if different than PCI.
****

PCI MNL-116 unless specified otherwise. Submit quality control procedures established in accordance with PCI MNL-116 by the precast manufacturer.

2.3.1 Forms

Brace forms to prevent deformation. Forms must produce a smooth, dense surface. Use forms and form-facing materials that are nonreactive with concrete such as wood, metal, plastic, or other approved materials. Conform to the shapes, lines, and dimensions indicated and are within the limits of the specified fabrication tolerances. Chamfer exposed edges of columns and beams 200 mm 3/4 inch, unless otherwise indicated. Provide threaded or snap-off type form ties.

2.3.2 Tolerances

Fabricate structural precast concrete members of shapes, lines and dimensions indicated, so each finished member complies with PCI MNL-135 product tolerances as well as position tolerances for cast-in items.

2.3.3 Reinforcement Placement

ACI 318MACI 318 and PCI MNL-116 for placement and splicing. Place and

secure steel bars, welded-wire reinforcement, and other reinforcement by means of metal bar supports and spacers. Reinforcement may be preassembled before placement in forms. Provide exposed connecting bars, or other approved connection methods, between precast [prestressed]and cast-in-place construction. Remove any excess mortar that adheres to the exposed connections.[Provide curvature or drape of the prestressing strands using approved hold-down devices.]

[2.3.4 Inserts

When the ends of the prestressed member will be exposed, recess the prestressing stands using inserts. After detensioning, remove inserts and fill the recess with nonshrink grout.

]2.3.5 Built-In Anchorage Devices

****
NOTE: Indicate anchorage devices that are to be embedded in the precast structural concrete sections. Anchorage devices include weld plates, bearing plates and steel shapes.
****

Position, anchor, and locate anchorage devices where they do not affect the position of the main reinforcement or placing concrete. Bearing plates; set level, aligned properly, and anchored in the exact location indicated.

2.3.6 Lifting Devices

Provide lifting devices designed for 100-percent impact, and of materials sufficiently ductile to ensure visible deformation before fracture.

2.3.7 Blockouts

****
NOTE: Blockouts or openings in slabs that would require the cutting of primary reinforcement if such openings were to be cut in the field ensure openings are cast in the unit during fabrication and indicated. The maximum size of field-cut openings may be from 150 to 300 millimeter 6 to 12 inches depending on the type of unit used such as the inside diameter of the voids in hollow core flat slabs and the spacing of reinforcement.
****

Provide blockouts as indicated.

2.3.8 Identification Markings

Clearly mark each structural section in a permanent manner to indicate its location and orientation in the building and the pickup points.

Ensure each structural section has the date of casting plainly indented in the unexposed face of the concrete.

2.3.9 Concrete

2.3.9.1 Concrete Mixing

ASTM C94/C94M. Mixing operations must produce batch-to-batch uniformity of strength, consistency, and appearance.

2.3.9.2 Concrete Placing

PCI MNL-116.

2.3.9.3 Concrete Curing

PCI MNL-116.

[2.3.10 Prestressing

****
NOTE: For normal prestressing use a release strength of 23 MPa 3500 psi, unless the design requires a higher release strength. Some release strengths are indicated in the PCI Design Handbook for selected prestressed members based on different load conditions, strand patterns, and span lengths.
****

PCI MNL-116. Do not transfer prestressing forces during detensioning until the concrete has reached a minimum compressive strength of [24 MPa] [3500 psi] [_____], unless a higher strength is required by the Contractor furnished design.

]2.3.11 Surface Finish

Repairs located in a bearing area must be approved by the Contracting Officer prior to repairs. Defects must be repaired or rejected as specified in paragraph ACCEPTANCE/REJECTION OF DEFECTS.

****
NOTE: Sample panels should only be required when a finish Grade A or better is specified.
****

[Submit two 300 by 300 by 50 mm 12 by 12 by 2 inch thick sample panels representative of the color and finish for each type of precast member requiring a finish Grade [A][_____] surface finish.

]2.3.11.1 Unformed Surfaces

Provide a [floated] [steel troweled] finish.

2.3.11.2 Formed Surfaces

****
NOTE: PCI MNL-116 different grades of formed surface finishes:

Commercial Grade: Concrete produced in forms that produce a rough finish. Fins are removed and large surface blemishes filled. Sharp edges that will be

visible in the finished structure are ground down.

Standard Grade: Same finish as commercial grade, except the forms do not produce a texture on the concrete. Surface can be painted, but will have surface voids.

Finish Grade B: Same as standard grade, except all surface blemishes should be filled or finished to provide a smooth surface or uniform appearance if painted.

Finish Grade A: Same as Finish Grade B, except that the components of the completed structure, where exposed, must be reasonably color matched. This finish is difficult to obtain.

****

PCI MNL-116, Appendix C, for grades of surface finishes.

a. Unexposed Surfaces: Provide a [commercial] [standard] grade surface finish.

b. Exposed Surfaces: Provide a [standard grade] [finish Grade B] [_____] surface finish.[The combined area of acceptable defective areas must not exceed 0.2 percent of the exposed to view surface area, and the patches must be indistinguishable from the surrounding surfaces when dry.][In addition to a Grade B surface finish, members must have a smooth rubbed finish.]

2.3.11.3 Architectural Finish

Provide a [finish Grade A] [_____] surface finish to those members indicated.

2.3.12 Acceptance/Rejection of Defects

2.3.12.1 Minor Defects

All honeycombed areas, chipped corners, air pockets over 6 mm 1/4 inch in diameter, and other minor defects involve less than 900 mm^2 36 square inches of concrete must be repaired. Form offsets of fins over 3 mm 1/8 inch must be ground smooth. All unsound concrete must be removed from defective areas prior to repairing. All surfaces permanently exposed to view must be repaired by a blend of portland cement and white cement properly proportioned so that the final color when cured will be the same as adjacent concrete. Precast [prestressed]members containing hairline cracks which are visible and are less than 0.25 mm 0.01 inches in width, may be accepted, except that cracks larger than 0.1 mm 0.005 inches in width for surfaces exposed to the weather must be repaired.

2.3.12.2 Major Defects

Major defects are those which involve more than 900 mm^2 36 square inches of concrete or expose stressing tendons or reinforcing steel. If one or more major defects appear in a member, it will be rejected. Cracks of a width of more than 0.25 mm 0.01 inch will be cause for rejection of the member.

2.4 TESTS, INSPECTIONS, AND VERIFICATIONS

****

NOTE: If marine environment or exposed to severe environmental conditions, recommend including chloride ion penetration requirements.

****

[2.4.1 Chloride Ion Concentration Test

Sampling and determination of water soluble chloride ion content in accordance with ASTM C1218/C1218M. Maximum water soluble chloride ion concentrations in hardened concrete at ages from 28 to 42 days contributed from the ingredients including water, aggregates, cementitious materials, and admixtures must not exceed 0.06 percent by weight of cement.

][2.4.2 Chloride Ion Penetration Test

To ensure the durability of concrete in marine environment, concrete must be proportioned to have the chloride ion penetration test in accordance with ASTM C1202, and be below 1500 coulombs for concrete specimens tested at 28 days.[Alternatively, a ponding test in accordance with AASHTO T 259 may be performed to validate chloride ion penetration in accordance with ASTM C1202.]

]2.4.3 Factory Inspection

****

NOTE: Check with the designer and Resident in Charge of Construction and edit appropriately.

****

At the option of the Contracting Officer, [precast[prestressed] units may be inspected by the Contracting Officer] [precast[prestressed] units must be inspected by the QC Representative] prior to being transported to the job site. The Contractor must 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.

PART 3 EXECUTION

3.1 EXAMINATION

Prior to erection, and again after installation, precast[prestressed] members must be checked for damage, such as cracking, spalling, and honeycombing. As directed by the Contracting Officer, precast[prestressed] members that do not meet the surface finish requirements specified in paragraph SURFACE FINISH must be repaired, or removed and replaced with new precast [prestressed]members.

3.2 ERECTION

Precast [prestresed]members must be erected after the concrete has attained the specified compressive strength, unless otherwise approved by the precast[prestressing] manufacturer. [In addition, prestressed members must not be rigidly fixed in position until the prestressed member has "aged" [90] [_____] days after detensioning.] Erect in accordance with the approved shop drawings. PCI MNL-135 for tolerances. Provide a 1:500

tolerance, if no tolerance is specified. Brace precast [prestressed]members, unless design calculations submitted with the shop drawings indicate bracing is not required. Follow the manufacturer's recommendations for maximum construction loads. Place precast[prestressed] members level, plumb, square, and true within tolerances. Align member ends.

3.3 BEARING SURFACES

Must be flat, free of irregularities, and properly sized. Size bearing surfaces to provide for the indicated clearances between the precast[prestressed] member and adjacent precast[prestressed] members or adjoining field placed surfaces. Correct bearing surface irregularities with nonshrink grout. Provide bearing pads where indicated or required. Do not use hardboard bearing pads in exterior locations. Place precast[prestressed] members at right angles to the bearing surface, unless indicated otherwise, and draw-up tight without forcing or distortion, with sides plumb.

3.4 ANCHORAGE

Provide anchorage for fastening work in place. Conceal fasteners where practicable. Make threaded connections up tight and nick threads to prevent loosening.

3.5 WELDING

AWS D1.1/D1.1M, AWS D1.4/D1.4M for welding connections and reinforcing splices. [Do not weld prestressing strands.]Protect the concrete and other reinforcing from heat during welding. Weld continuously along the entire area of contact.[Grind smooth visible welds in the finished installation.] Welding of epoxy-coated reinforcing is not allowed.

3.6 OPENINGS

Holes or cuts requiring [reinforcing][prestressing steel]to be cut, which are not indicated on the approved shop drawing, must only be made with the approval of the Contracting Officer and the precast manufacturer. Drill holes less than 300 mm 12 inches in diameter with a diamond tipped core drill. Ensure cuts are straight and at 90 degrees to the surfaces without breaking or spalling the edges.

3.7 GALVANIZING REPAIR

Repair damage to galvanized coatings using ASTM A780/A780M zinc rich paint for galvanized surfaces damaged by handling, transporting, cutting, welding, bolting, or acid washing. Do not heat surfaces to which repair paint has been applied.

3.8 GROUTING

Clean and fill [indicated] keyways between precast[prestressed] members, and other indicated areas, solidly with nonshrink grout or cementitious grout. Provide reinforcing where indicated. Remove excess grout before hardening.

3.9 SEALANTS

Provide as indicated and as specified in Section 07 92 00 JOINT SEALANTS.

3.10 PROTECTION AND CLEANING

****

NOTE: Ensure where architecturalfinishes such as exposed-aggregate finish are specified for exposed-to-view surfaces, such surfaces are cleaned as specified in Section 03 45 00 PRECAST ARCHITECTURAL CONCRETE.

****

Protect exposed-to-view surfaces against staining and other damage until completion of the work.

Upon completion of installation, swept clean and leave ready slab surfaces to receive concrete floor topping, roofing, or other covering.

[3.11 CONCRETE TOPPING

Provide as indicated and as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

][3.12 CONSTRUCTION RECORDS

Complete construction records must be kept of the manufacturing, handling, and erection of the precast-prestressed concrete members and submitted. Records must be kept for, but not limited to, the following items:

a. Specifications of material used in the manufacture of the members.

b. Time-temperature history of the concrete members from casting to the transfer of the prestress force.

c. Records of the tendon stressing operation including initial prestress force, measured elongation, how it was measured, and how the tendons were stressed and destressed.

d. Records of inspection of the members before and after the prestress force is transferred to the members.

e. Records of the inspection of the members each time they are moved.

f. Records of any defects in the member and any corrective measures taken.

]

-- End of Section --