



Engineering Standard

SAES-Q-012

3 July 2012

Criteria for Design and Construction
of Precast and Prestressed Concrete Structures

Document Responsibility: Civil Standards Committee

Saudi Aramco DeskTop Standards

Table of Contents

1	Scope.....	2
2	Conflicts and Deviations.....	2
3	References.....	2
4	Design.....	5
5	Materials.....	8
6	Fabrication.....	10
7	Delivery, Storage and Handling of Material..	12
8	Erection.....	13
9	Inspection and Testing.....	14
10	Offshore Concrete Structures.....	15

Previous Issue: 11 July 2006 Next Planned Update: 3 July 2017

Revised paragraphs are indicated in the right margin

Primary contact: [Mehthel, Mohammed Heshan](#) on 966-3-880-9503

Page 1 of 15

1 Scope

- 1.1 This standard covers the design, material specifications, manufacturing and erection of precast and prestressed concrete products including building components such as columns, beams, hollow core slabs, single and double tees, wall panels, decorative fences and marine trestles, etc.

Commentary Note:

Precast concrete is the concrete that is produced in accordance to [SAEP-1152](#) by an approved concrete plant and manufactured under plant control conditions

2 Conflicts and Deviations

- 2.1 Any conflicts between this standard and other applicable Saudi Aramco Engineering Standards (SAESs), Saudi Aramco Materials System Specifications (SAMSSs), Standard Drawings (SASDs), or industry standards, Codes, and Forms shall be resolved in writing by the Company or Buyer Representative through the Manager, Consulting Services Department of Saudi Aramco, Dhahran.
- 2.2 Direct all requests to deviate from this standard in writing to the Company or Buyer Representative, who shall follow internal company procedure [SAEP-302](#) and forward such requests to the Manager, Consulting Services Department of Saudi Aramco, Dhahran.

3 References

The selection of material and equipment, and the design, construction, maintenance, and repair of equipment and facilities covered by this standard shall comply with the latest edition of the references listed below, unless otherwise noted.

3.1 Saudi Aramco References

Saudi Aramco Engineering Procedures (SAEP)

[SAEP-302](#)

Instructions for Obtaining a Waiver of a Mandatory Saudi Aramco Engineering Requirements

[SAEP-1152](#)

Approval Procedure for Ready-Mixed Concrete Mix Design

Saudi Aramco Engineering Standards (SAES)

[SAES-H-001](#)

Coating Selection and Application Requirements for Industrial Plants and Equipment

<u>SAES-M-100</u>	<i>Saudi Aramco Building Code</i>
<u>SAES-Q-001</u>	<i>Criteria for Design and Construction of Concrete Structures</i>
<u>SAES-Q-005</u>	<i>Concrete Foundations</i>
<u>SAES-Q-010</u>	<i>Cement Based, Non-Shrink Grout for Structural and Equipment Grouting</i>
<u>SAES-Q-011</u>	<i>Epoxy Grout for Machinery Support</i>

Saudi Aramco Materials System Specifications (SAMSS)

<u>09-SAMSS-088</u>	<i>Aggregates for Concrete</i>
<u>09-SAMSS-097</u>	<i>Ready-Mixed Portland Cement Concrete</i>
<u>09-SAMSS-106</u>	<i>Epoxy Coating of Steel Reinforcing Bars</i>

3.2 Industry Codes and Standards

Precast and Prestressed Concrete Institute (PCI)

<i>PCI MNL-116</i>	<i>Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products, Fourth Edition</i>	
<i>PCI MNL-117</i>	<i>Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products, Third Edition</i>	
<i>PCI MNL-120</i>	<i>PCI Design Handbook - Precast and Prestressed Concrete</i>	
<i>PCI MNL-122</i>	<i>Manual for Structural Design of Architectural Precast Concrete, Second Edition</i>	
<i>PCI MNL-123</i>	<i>Design and Typical Details of Connections for Precast and Prestressed Concrete</i>	
<i>PCI-MNL-127</i>	<i>Erector's Manual: Standards and Guidelines for the Erection of Precast Concrete Products</i>	
<i>PCI-MNL-132</i>	<i>Erection Safety Manual for Precast and Prestressed Concrete</i>	
<i>PCI MNL-135</i>	<i>Tolerance Manual for Precast and Prestressed Concrete Construction</i>	
<i>PCI-MNL-138</i>	<i>Connection Manuals of of Connections for Precast and Prestressed Concrete</i>	

PCI-MNL-140 Sismic Design of Precast/Prestressed Concrete Structures

American Concrete Institute (ACI)

<i>ACI 201.2R</i>	<i>Guide to Durable Concrete</i>
<i>ACI 211.1</i>	<i>Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete</i>
<i>ACI 211.2</i>	<i>Standard Practice for Selecting Proportions for Structural lightweight concrete</i>
<i>ACI 305R</i>	<i>Hot Weather Concreting</i>
<i>ACI 318M</i>	<i>Building Code Requirements for Reinforced Concrete</i>
<i>ACI 347R</i>	<i>Guide to Formwork for Concrete</i>
<i>ACI 350</i>	<i>Code Requirements for Environmental Engineering Concrete Structures and Commentary</i>
<i>ACI 533</i>	<i>Guide for Precast Concrete Wall Panels</i>
<i>ACI SP-66</i>	<i>Detailing Manual – Details and Detailing of Concrete Reinforcement</i>

American Society for Testing and Materials (ASTM)

<i>ASTM A36</i>	<i>Standard Specification for Carbon Structural Steel</i>
<i>ASTM A53</i>	<i>Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Zinc Coated, Welded and Seamless</i>
<i>ASTM A325</i>	<i>Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength</i>
<i>ASTM A416</i>	<i>Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete</i>
<i>ASTM A767</i>	<i>Standard Specification for Zinc-Coated (Galvanized) Steel Bars for concrete Reinforcement</i>
<i>ASTM A775</i>	<i>Standard Specification for Epoxy-Coated Reinforcing Bars</i>
<i>ASTM A884</i>	<i>Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement</i>
<i>ASTM A992/A992M</i>	<i>Standard Specification for Structural Steel Shapes</i>

ASTM C39 *Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens*

ASTM C330 *Standard Specification for Lightweight Aggregates for Structural Concrete*

American Welding Society (AWS)

AWS D1.1 *Structural Welding Code - Steel*

AWS D1.4 *Structural Welding Code - Reinforcing Steel*

British Standards Institution (BS)

BS 1881 Part 124 *Methods for Analysis of Hardened Concrete*

Saudi Arabian Standards Organization (SASO)

SSA-2/1992 *Steel Bars for the Reinforcement of Concrete*

SSA-224/1981 *Steel Fabric for Reinforcement of Concrete*

4 Design

- 4.1 Structural design of all members and their connections shall be the responsibility of the Contractor. The design shall be performed by qualified and competent structural engineer.
- 4.2 The design shall be in accordance with ACI 318/318M, PCI Design Handbook (MNL-120) and PCI Manual (MNL-122). Prior to precast concrete fabrication, structural design calculations, design drawings and shop drawings including lifting details and capacities (Safe Working Load – SWL) shall be submitted to Saudi Aramco for review and approval. Such review shall not relieve the precast concrete Manufacturer of any design responsibility.
- 4.3 The Prestressed Concrete Institute (PCI) Design Handbook shall be the basis for analysis and design of precast and prestressed concrete structures.
- 4.4 Connections for precast/ prestressed concrete shall be in accordance with PCI-MNL 123 and PCI-MNL 138.
- 4.5 Seismic design for precast/prestressed concrete shall be in accordance with PCI-MNL 140.
- 4.6 Compressive Strength

For standard weight concrete, the minimum 28 day design compressive strength shall be 34.5 MPa (5000 psi). The minimum cement content for precast

concrete shall be per Section 5.1 below. Release strength for prestressed unit shall be 24.1 MPa (3500 psi) minimum.

Commentary Note:

Release strength is the minimum strength at time of release of the prestressing strands.

For lightweight concrete, the minimum 28 day design compressive strength shall be 34.5 MPa (5000 psi) and air-dry density of not less than 14.14 Kn/m³ (90 lbs/ft³) nor more than 18.07 Kn/m³ (115 lbs/ft³).

4.7 Minimum Floor & Roof Live Loads

Floor and roof live loads shall be per [SAES-M-100](#) "Saudi Aramco Building Code."

4.8 Precast concrete work shall be designed to carry all dead and superimpose loads indicated, including hanging loads and lateral loads, including loads arising from storage, handling and transportation.

4.8 Camber and Deflection

Design flexural members with sufficient camber to properly offset deflection under superimposed dead loads, which should be shown on design drawings.

4.9 The proportions of ingredients in the concrete mix shall be selected in accordance with provisions of ACI 211.1 for normal weight concrete and ACI 211.2 for lightweight concrete. The water cement ratio (w/c) shall not exceed 0.40.

4.10 ACI 201.2R "Guide to Durable Concrete" shall be used to specify special concreting and concrete protection requirements. Concrete exposure to corrosive materials, stray electrical current and abrasion shall be determined, and special protection for the concrete and reinforcement shall be provided.

4.11 The Contractor shall submit design drawings and structural design calculations to Saudi Aramco representative for review and approval. The design calculations shall include the following:

4.11.1 Stresses in members due to bending, shear, compression, tension, and torsion caused by vertical loads, prestressing forces and handling.

4.11.2 Stresses at release of prestressing force.

4.11.3 Camber and deflection.

4.11.4 Ultimate capacity of the members.

- 4.11.5 Stresses in members due to shrinkage, creep, and thermal expansion.
- 4.11.6 Secondary stresses due to prestressing force.
- 4.12 The design of the bearings and connections shall take into account tolerances allowed in the construction and erection of members as per PCI/ACI specifications and the stresses due to shrinkage, creep, thermal expansion and contraction, and deflection of members being connected.
- 4.13 Concrete Cover
- The minimum concrete cover for Prestressed Concrete is listed in ACI 318 Section 7.7.
- 4.14 The maximum water soluble chloride ions and sulfates as SO_3 in concrete shall be in accordance with [09-SAMSS-097](#) Section 6.1.
- 4.15 Welding
- The details of welded joints for embedded plates shall conform to the requirements of the latest edition of AWS D1.1, "Structural Welding Code". Welding shall be in accordance with AWS D1.4 for reinforcing steel.
- 4.16 Anchor Bolts and Embedded Items
- 4.16.1 The design of anchor bolts shall be in accordance with paragraph 4.8 of [SAES-Q-005](#).
- Commentary Note:*
- [SAES-Q-005](#) applies to foundation bolts only and not other embeds.*
- 4.16.2 Metallic sleeves are not allowed and anchor bolts shall be secured to prevent movement or tilting of the anchor bolts during concrete placement/ casting.
- 4.16.3 All sleeves, inserts, anchor bolts, waterstops and other embedded items shall be installed in accordance with the design/fabrication drawings and supported against displacement.
- 4.16.4 Tolerance for inserts and construction shall be in accordance with PCI-MNL-135.
- 4.16.5 Projecting steel items (such as grating angles, slide plates, unistrut, steel plates, etc.) which are attached to the formwork and cast at the concrete surface shall be hot dip galvanized. Additionally, the steel bar which anchors these items to the concrete shall be similarly galvanized.

- 4.16.6 Reinforcing steel bars, anchor bolts or other steel embedment shall not be used as the means for grounding electrical equipment and shall not be tied to grounding neutral conductors, or any part of the lightning protection system.
- 4.16.7 Conduits, pipes and other items made from aluminum shall not be embedded in structural concrete unless effectively coated/isolated to prevent aluminum-concrete reaction.
- 4.17 Precast wall panels shall be in accordance with ACI 533.
- 4.18 Water and environmental concrete structures shall be in accordance with ACI 350.
- 4.19 Erection and safety of erection shall be in accordance with PCI-MNL-127 and PCI-MNL-137.

5 Materials

The concrete materials shall be in accordance with [09-SAMSS-097](#) “Ready-Mixed Portland Cement Concrete” and as follows:

5.1 Cement

Portland cement type shall be per Section 5.1 - Table 1 of [SAES-Q-001](#) “Criteria for Design and Construction of Concrete Structures”. The minimum cement content for precast concrete shall be 370 Kg/M³ of concrete.

Commentary Note:

No maximum cement content is specified for precast concrete. It is usually common practice to specify cement content of more than 370 Kg/M³ of concrete in the precast concrete industry.

5.2 Aggregates

Aggregates used in concrete shall be per [09-SAMSS-088](#) “Aggregate for Concrete”. For lightweight concrete, aggregates shall be in accordance with ASTM C330.

5.3 Water

Quality of water in concrete shall be per Section 5.4 and Table B of [09-SAMSS-097](#) “Ready-Mixed Portland Cement Concrete.”

5.4 Admixtures

Admixtures used in concrete shall be per Section 5.6 of [09-SAMSS-097](#)

“Ready-Mixed Portland Cement Concrete”. Calcium chloride as an admixture shall not be used in precast and prestressed concrete.

5.5 Epoxy Grout

Epoxy grout shall be per [SAES-Q-011](#) “Epoxy Grout for Machinery Support”.

5.6 Non-Shrink Grout

Cement-based non-shrink grout shall be per [SAES-Q-010](#) “Cement Based, Non-Shrink Grout for Structural and Equipment Grouting”.

5.7 Pigments

Pigments or other coloring agents, when required, shall be resistant to lime and other alkalis.

5.8 Reinforcing Bars

Reinforcing steel bars shall conform to SASO SSA-2, hot-rolled, high tensile, deformed steel. These bars shall be acceptable under the ACI 318M specified limitation of 422 MPa (60 ksi). ACI 318M reinforcing specifications are based on ASTM metric standards. Bar supports shall be solid plastic. Reinforcing steel type shall be per Table 1 of [SAES-Q-001](#).

5.9 Galvanized welded wire fabric shall conform to ASTM A767 and shall be acceptable reinforcement in lieu of epoxy coated welded wire fabric coated in accordance with ASTM A884.

5.10 Coated reinforcement shall be Fusion bonded Epoxy in accordance with [09-SAMSS-106](#).

5.11 Manufacture, fabrication, handling, placement and storage of reinforcement shall be in accordance with chapter 7 of ACI 318. Handling and fabrication of the Epoxy coated reinforcement shall be in accordance with ASTM A775 Appendix, and Concrete Reinforcing Steel Institute (CRSI).

Commentary Note:

Care should be taken to avoid any damage to the coated rebars during shipment, handling, fabrication and placement of the coated rebars. The extent of the damage and repair of the coating shall be in accordance with [09-SAMSS-106](#).

5.12 Welded Wire Fabric

Welded wire fabric shall conform to SASO SSA-224, (cold drawn) wire with a minimum yield strength of 240 MPa (34.8 ksi).

5.13 Prestressing Tendons

Strands shall be uncoated, 7-wire “low relaxation” strand conforming to ASTM A416 with a minimum strength of 250,000 psi (Grade 250) unless grade 270 is indicated. Epoxy coated strands shall not be used for prestressed concrete.

5.14 Formwork

Provide forms necessary to produce the required finish surfaces and precast units of the shapes, lines and dimensions indicated, within the required fabrication tolerances. Forms shall be of sufficient strength to withstand pressures due to fabrication operations. Forms shall be free of noticeable wrinkles, dents, patches, and other such defects. Contact surface of forms shall be clean, free of ruts and other roughness. Form joints shall be tight and free of defects. Provisions shall be made that all temporary handling items shall be invisible in the finished product work and protected against deterioration due to the elements. The design and construction of the formwork shall be in accordance with ACI 347R and Saudi Aramco Construction Safety Manual. For forms removal for precast members, refer to paragraph 7.6.5 of ACI 347R-03.

5.15 Connection Material

Provide plates and shapes required for the support of precast units, either embedded in the shop or shipped loose, as shown on the drawings or as required. Provide steel plates or shapes galvanized after assembly. Structural steel material shall be as follows:

- Steel plates: Structural quality, hot-rolled carbon steel, ASTM A36
- Steel shapes (W and WT): ASTM A992/A992M
- Steel pipe: ASTM A53, Type E or S, Grade B, galvanized.
- Provide high strength, ASTM A325, galvanized steel bolts, nuts, and washers for connections.
- Provide standard stainless steel threaded inserts in terms of all single and double tee roof members complete with removable plastic caps, spacing to be 1220 mm (4'-0”) on center (o.c.) throughout capable of carrying 4.45 Kn (1,000 pound) per insert. Additional inserts to be provided as shown on drawings.

6 Fabrication

- 6.1 All precast prestressed concrete members shall be fabricated in accordance with Prestressed Concrete Institute, Manual for Quality Control for Plants and

Production of Precast Prestressed Concrete Products MNL-116. Before shipment, all concrete members shall be inspected and approved by the Manufacturer's Quality Control Department to make certain that the materials and workmanship conform to the requirements of these specifications.

6.2 All architectural precast concrete members shall be fabricated in accordance with Prestressed Concrete Institute, Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products MNL-117. Before shipment, all concrete members shall be inspected and approved by the Manufacturer's Quality Control Department to make certain that the materials and workmanship conform to the requirements of these specifications.

6.3 All concrete surfaces in direct contact with earth shall be coated of coal tar or bitumen coating that conforms to APCS-3 or APCS-10 of SAES-in accordance to [SAES-H-001](#).

Commentary Note:

APCS-10 shall not be used where soil is contaminated with hydrocarbons.

6.4 All precast members where the reinforcement protrudes through the surface or where shadow lines caused by reinforcement too near the surface shall be rejected.

6.5 Dimensional tolerances shall not exceed those recommended in the PCI Manual of Quality Control (MNL-116, MNL-117 and MNL-135) with the following exceptions:

- Wall panels shall have no camber and differential bowing between adjacent panels shall not exceed 3 mm ($\frac{1}{8}$ of an inch). Total maximum bowing due to thermal stresses, etc., shall not exceed $\frac{1}{360}$ of panel length.
- Differential camber between adjacent members other than wall panels shall not exceed 10 mm ($\frac{3}{8}$ of an inch). Where the differential camber exceeds this value, a fill shall be installed and feathered out on a 1-in-12 slope.
- Differential camber between adjacent members for Prestressed Concrete Double Tees shall not exceed 6 mm ($\frac{1}{4}$ of an inch).

6.6 Chamfer shall be provided at exposed edges of columns and beams unless shown otherwise.

6.7 Reinforcing steel, where required, shall be supported with plastic or galvanized chairs. However, the use of PVC Schedule 80 pipe as spacer is allowed. The PVC pipe shall be notched at the bottom to allow the ingress of concrete. Typical samples shall be submitted for supervisor of Civil Engineering

Unit/CSD for approval. Reinforcement detailing shall be in accordance with ACI SP-66.

6.8 Finishing

6.8.1 Finish of exterior surfaces shall be in accordance with the Project Specifications and as shown on contract drawings.

6.8.2 All lifting devices shall be recessed.

6.9 Curing

6.9.1 Steam curing can be used for precast concrete.

6.9.2 When water curing is used, it shall be in accordance with Section 10 of [SAES-Q-001](#).

6.10 When hot weather condition exists, concrete shall be placed in compliance with ACI 305R.

6.11 Samples

Samples showing various finishes as required and specified for the project shall be submitted in sufficient number until a control sample for each finish is approved by Saudi Aramco Representative. Submit for approval 400 mm by 400 mm by 40 mm (16 inch by 16 inch by 1- $\frac{3}{4}$ inch) samples of precast concrete units. A full size panel or member shall be prepared at the plant to be reviewed and approved by Saudi Aramco Representative. This approval sample shall be retained and used for reference as the standard for quality, color and texture for the Project.

6.12 Openings in Precast and Prestressed Units

Location of openings for ducts, exhaust fans, cable trays, piping, etc. shall be inspected, checked and verified against design drawings during fabrication of all precast and prestressed concrete members.

7 Delivery, Storage and Handling of Material

7.1 Prestressed concrete members shall be lifted and supported only at the lifting and support points shown on the shop drawings during handling, storing, and transporting. Proper equipment and methods of bracing shall be used during transporting to ensure the members shall arrive at the jobsite undamaged. Members damaged by handling, transporting, or storing shall be rejected and replaced with undamaged members without any expense to Saudi Aramco.

- 7.2 Members shall be kept free of mud and other damaging materials at all times, and shall be stored at the jobsite on non-staining wooden pallets or platforms in such a manner to ensure drainage and drying when exposed to the elements.
- 7.3 Store and transport members in a manner to prevent the occurrence of excessive stresses or cracking. Lift and support units at the designate lift points only.
- 7.4 Store molds in such a manner to protect them from damage that could result in dimensional change or general surface or structural degradation.

8 Erection

- 8.1 Prior to the erection of any precast member, the structural component to which the member is to be attached shall be checked for elevation and alignment. Acceptable deviations in these structural components shall be dimensionally compensated for when erecting the precast members. All precast members shall be installed in proper sequence and adequate temporary supports shall be provided to control alignment, deflection, and stress levels.
- 8.2 Precast units shall be lifted during erection only at the lifting points shown on the shop drawings.
- 8.3 Precast members shall be grouted where called for on the drawings. The space to be occupied by the grout shall be thoroughly cleaned, removing all dirt, oil, grease and loose material. The grout shall be mixed in accordance with the manufacturer's specifications.
- 8.4 Anchor members to supporting bearing surfaces as shown on the design Drawings. Members shall be anchored together at intervals along their length as recommended by manufacturer. Welding of members shall be at places shown on the drawings or where required and by approved welders.
- 8.5 Precast units shall be lifted during erection only at the lifting points shown on the shop drawings. All lifting devices shall be removed from erected precast units.
- 8.6 Field-Placed Inserts
 - 8.6.1 Field-placed inserts, such as hand-drilled or power driven inserts and studs, may not be placed in members unless approved by Saudi Aramco Representative. The installation of field-placed inserts shall not interfere with prestressing steel. Power driven inserts and studs shall be located an adequate distance from concrete edges and corners to prevent spalling.

- 8.6.2 Field cutting or drilling holes in the stems of double tees is not allowed unless supported with structural calculations and the insert will not cut the reinforcement

Commentary Note:

Drilled in bolts is usually needed to hang items such as lighting, sprinkler pipes, suspended ceiling, etc.

- 8.6.3 If supported with structural calculations, field cutting openings in the flanges of double tees to be limited to one 600 mm by 600 mm (2'-0" by 2'-0") opening per panel unless approved by Saudi Aramco Representative.

- 8.6.4 If supported with structural calculations, field cutting in solid wall panels shall be limited to 250 mm (10-inch) round opening unless approved by Saudi Aramco Representative.

- 8.7 All precautions shall be taken to avoid damage to other work. Any work or materials damaged to such extent that they cannot be restored to their original condition shall be replaced.

- 8.8 All prestressed concrete members shall be erected into final position by competent erection personnel, erection equipment and methods acceptable to the Fabricator and under the direct on-site Technical Guidance of the Fabricator.

- 8.9 Erection of precast concrete shall be in accordance with PCI-MNL-127 and PCI-MNL-132.

9 Inspection and Testing

Inspection and testing shall be in accordance with Section 16 of [SAES-Q-001](#). Supplier shall institute Quality Control procedures for the manufacture, inspection and testing of precast units in compliance with PCI-MNL-116 and PCI-MNL-117. Furnish certification of Quality Control test results.

- 9.1 Quality control for the production of precast prestressed concrete shall be per the "Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products" PCI-MNL-116.

- 9.2 Quality control for the production of architectural precast concrete shall be per the "Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products" PCI-MNL-117.

9.3 Performance Evaluation

Precast units may be rejected for any of the following:

- Defects as listed in PCI MNL-116, as applicable
- Surfaces with finish deficiencies
- Damage during lifting, transporting and construction operations
- Excessive dimensional variations

9.4 Defective Work

Repair as per approved repair procedure submitted by manufacturer or replace precast units which do not conform to the specified requirements. The Supplier shall be responsible for the cost of correcting other work affected by or resulting from corrections to the precast concrete work.

10 Offshore Concrete Structures

A full environmental evaluation for concrete marine structures shall be performed per Section 17 of [SAES-Q-001](#). The evaluation shall include identification of marine organisms including rock boring mollusks and sponges that would pose a threat to the precast and prestressed concrete structure and its integrity.

Revision Summary

3 July 2012 Revised the "Next Planned Update." Reaffirmed the content of the document, and reissued with minor revisions.