ACI 349-13

Code Requirements for Nuclear Safety-Related Concrete Structures (ACI 349-13) and Commentary

An ACI Standard

Reported by ACI Committee 349

American Concrete Institute®

First Printing
June 2014

American Concrete Institute®
Advancing concrete knowledge

Code Requirements for Nuclear Safety-Related Concrete Structures and Commentary

The technical committees responsible for ACI committee reports and standards strive to avoid ambiguities, omissions, and errors in these documents. In spite of these efforts, the users of ACI documents occasionally find information or requirements that may be subject to more than one interpretation or may be incomplete or incorrect. Users who have suggestions for the improvement of ACI documents are requested to contact ACI via the errata website at www.concrete.org/committees/errata.asp. Proper use of this document includes periodically checking for errata for the most up-to-date revisions.

ACI committee documents are intended for the use of individuals who are competent to evaluate the significance and limitations of its content and recommendations and who will accept responsibility for the application of the material it contains. Individuals who use this publication in any way assume all risk and accept total responsibility for the application and use of this information.

All information in this publication is provided "as is" without warranty of any kind, either express or implied, including but not limited to, the implied warranties of merchantability, fitness for a particular purpose or non-infringement.

ACI and its members disclaim liability for damages of any kind, including any special, indirect, incidental, or consequential damages, including without limitation, lost revenues or lost profits, which may result from the use of this publication.

It is the responsibility of the user of this document to establish health and safety practices appropriate to the specific circumstances involved with its use. ACI does not make any representations with regard to health and safety issues and the use of this document. The user must determine the applicability of all regulatory limitations before applying the document and must comply with all applicable laws and regulations, including but not limited to, United States Occupational Safety and Health Administration (OSHA) health and safety standards.

Participation by governmental representatives in the work of the American Concrete Institute and in the development of Institute standards does not constitute governmental endorsement of ACI or the standards that it develops.

Order information: ACI documents are available in print, by download, on CD-ROM, through electronic subscription, or reprint and may be obtained by contacting ACI.

Most ACI standards and committee reports are gathered together in the annually revised ACI Manual of Concrete Practice (MCP).

American Concrete Institute
38800 Country Club Drive
Farmington Hills, MI 48331
U.S.A.
Phone: 248-848-3700
Fax: 248-848-3701

www.concrete.org

ISBN: 978-0-87031-894-8

ACI 349-13

Code Requirements for Nuclear Safety-Related Concrete Structures (ACI 349-13) and Commentary

An ACI Standard

Reported by ACI Committee 349

Herman L. Graves III, Chair
Adeola K. Adediran, Vice Chair

Partha S. Ghosal, Vice Chair
Lisa M. Anderson, Secretary

Omesh B. Abhat
Taha D. Al-Shawaf
Ranjit L. Bandyopadhyay*
Harry A. Chambers
Ronald A. Cook
Rolf Eligehausen
Farhad Farzam
Werner A. F. Fuchs
Stewart C. Gallocher
Branko Galunic
Orhan Gurbuz
James A. Hammell
Joseph Kendall Harrold
Gunnar A. Harstead
Christopher Heinz
Charles J. Hookham
Ronald J. Janowiak
Scott A. Jensen
Richard E. Klingner
Nam-Ho Lee
Javeed Munshi
Dan J. Naus
Dragos A. Nuta
Richard S. Orr
Anton D. Pirtz
John F. Silva
Bozidar Stojadinovic
Barendra K. Talukdar
Donald T. Ward
Andrew S. Whittaker
Albert Y. C. Wong
Charles A. Zalesiak

Consulting Members
Hansraj G. Ashar
Peter J. Carrato
Mukti L. Das

The committee recognizes the following non-voting members for their contributions to the development of the code revision: Monzer M. Allam, Jorg NMI Asmus, Matthew Dominick D'Ambrosia, Chiara F. Ferraris, Ola Jovall, Angela McAlpin, Michael C. Mota, Nebojsa Orbovic, Debi Ramos, Madhumita Sircar, and J. Bret Turley.

*Ranjit L. Bandyopadhyay was a long-time member of ACI Committee 349 and the Committee Chair of ACI 349 at the time of his death in 2010. The committee expresses its appreciation for his friendship and leadership.

This standard covers the proper design and construction of concrete structures that form part of a nuclear power plant and that have nuclear safety-related functions, but does not cover concrete reactor vessels and concrete containment structures (as defined by Joint ACI-ASME Committee 359).

The structures covered by the Code include concrete structures inside and outside the containment system.

This Code may be referenced and applied subject to agreement between the owner and the Regulatory Authority.

All notation sections have been removed from the beginning of each chapter and consolidated into one list in Chapter 2.

The format of this Code is based on the "Building Code Requirements for Structural Concrete (ACI 318-08)" and incorporates recent revisions of that standard.

The commentary, which is presented after the Code, discusses some of the considerations of ACI Committee 349 in developing "Code Requirements for Nuclear Safety-Related Concrete Structures (ACI 349-13)." This information is provided in the commentary because the Code is written as a legal document and therefore cannot present background details or suggestions for carrying out its requirements.

Keywords: anchorage; authority having jurisdiction (AHJ); beam-column frame; beams; building codes; columns; composite construction; concrete cover; cracking (fracturing); creep; curing; deep beams; deflection; earthquake-resistant structures; floors; folded plates; footings; formwork; inspection; joints; joists; load tests; loads; mixture proportioning; modulus of elasticity; nuclear power plants; nuclear reactor containments; nuclear reactor safety; nuclear reactors; precast concrete; prestressed concrete; quality control; reinforced concrete; safety; serviceability; shear strength; shearwalls; shells; slabs; specifications; splicing; structural analysis; structural design; temperature; torsion; walls.

The materials, processes, quality control measures, and inspections described in this document should be tested, monitored, or performed as applicable only by individuals holding the appropriate ACI Certification or equivalent.

ACI 349-13 supersedes ACI 349-06, was adopted August 15, 2013, and published June 2014.

CONTENTS

Page left intentionally blank.

CODE

INTRODUCTION

This Code covers the design and construction of concrete structures that form part of a nuclear facility and that have nuclear safety-related functions, but does not cover: i) Concrete reactor vessels and concrete containment structures, as defined by Joint ACI-ASME Committee 359; or ii) Steel-plate composite walls and steel-plate composite slabs, as defined by AISC-N690 Technical Committee 12.

The structures covered by this Code include concrete structures inside and outside the containment system.

This Code may be referenced and applied subject to agreement between the owner and the Regulatory Authority.

All notation sections have been removed from the beginning of each chapter and consolidated into one list in Chapter 2.

The format of this Code is such that it depends on the "Building Code Requirements for Structural Concrete (ACI 318-08) and Commentary" and any applicable errata issued up to September 2011, and should be used in conjunction with that Code and applicable issued errata.

The Commentary, which is presented after the Code, discusses considerations of ACI Committee 349 in developing, "Code Requirements for Nuclear Safety-Related Concrete Structures (ACI 349-13)." This information is provided in the Commentary because this Code is written as a legal document and, therefore, cannot present background details or suggestions for carrying out its requirements. For design of nuclear structures, in cases of conflict between this Code with other documents, except wherever this Code is in conflict with the specific requirements of the authority having jurisdiction (AHJ), ACI 349 shall govern.

The materials, processes, quality control measures, and inspections described in this Code should be tested, monitored, or performed as applicable only by individuals holding the appropriate ACI Certifications or equivalent.

COMMENTARY

INTRODUCTION

This Commentary discusses some of the considerations of Committee 349 in developing the provisions contained in "Code Requirements for Nuclear Safety-Related Concrete Structures (ACI 349-13)" hereinafter called the Code. The Code is based on "Building Code Requirements for Structural Concrete (ACI 318-08)," which is hereinafter called the Building Code. In preparing ACI 349-13, the committee has followed the text of the Building Code wherever appropriate.

Structural plain concrete, as described in Chapter 22 of ACI 318-08, is not endorsed for use in nuclear safety-related structures.

In the following commentary, all references to the Building Code and its commentary are to the 2008 revision unless specifically noted otherwise. Provisions of the commentary of ACI 318-08 apply except:

- The term "building official" is replaced with the term "licensed design professional";
- λ, the modification factor for lightweight concrete, is not applicable for ACI 349-13 structures. The value of λ for ACI 349-13 structures is 1.0.

Page left intentionally blank.

CODE

CHAPTER 1—GENERAL REQUIREMENTS

1.1—Scope

1.1.1 This Code provides minimum requirements for design and construction of nuclear safety-related concrete structures and structural members for nuclear facilities. Safety-related structures and structural members subject to this Code are those concrete structures that support, house, or protect nuclear safety class systems or component parts of nuclear safety class systems.

Specifically excluded from this Code are those structures covered by "Code for Concrete Containments," ASME Boiler and Pressure Vessel Code Section III, Division 2, and pertinent General Requirements (ACI 359).

This Code includes design and loading conditions that are unique to nuclear facilities, including shear design under biaxial tension conditions, consideration of thermal and seismic effects, and impact and impulsive loads.

For structural concrete, f_c' shall not be less than 3000 psi, unless otherwise specified.

1.1.2 This Code shall govern in all matters pertaining to design and construction of reinforced concrete structures, as defined in 1.1.1, except wherever this Code is in conflict with the specific provisions of the authority having jurisdiction (AHJ).

1.1.3 Same as ACI 318-08.

1.1.4 Intentionally left blank.

COMMENTARY

R1—GENERAL REQUIREMENTS

The commentary on ACI 318-08 is applicable to this chapter except as described as follows.

R1.1—Scope

The American Concrete Institute "Code Requirements for Nuclear Safety-Related Concrete Structures (ACI 349-13)," called the Code, provides minimum requirements for reinforced concrete design or construction in applications where protection against potential radioactive releases is a concern. The scope of the Code provides requirements for the analysis, design, construction, testing, and evaluation of new and existing concrete nuclear structures. While the requirements of this Code pertain primarily to new concrete structures, corresponding recommendations for the evaluation of existing concrete nuclear structures are provided in ACI 349.3R.[1.1] Some special structures involve unique problems that are not covered by the Code, such as structures that function as leakage barriers to contain the effects of the loss of coolant accident. The owner is to identify nuclear safety-related structures and establish which of them are covered by "Code for Concrete Containments (ACI 359)"[1.2] and its latest revisions instead of this Code. The Code is applicable to radioactive waste repository structures; however, considerations of thermal loads, load combinations, and long-term durability should be considered.

R1.1.1 In general, the Code requirements are based on test results from concrete specimens having a compressive strength of 6000 psi or less. Although no maximum concrete compressive strength is specified, the applicability of various requirements and formulations should be verified when concrete compressive strengths are higher than 6000 psi.

Minimum compressive concrete strength has been established as 3000 psi to be consistent with the seismic provisions of Chapter 21 of ACI 349-13 and ACI 318.

R1.1.4 Intentionally left blank, as this Code does not deal with residential structures.