

**ACI 376M-11**

(metric)

**Code Requirements for Design  
and Construction of Concrete  
Structures for the Containment of  
Refrigerated Liquefied Gases and  
Commentary**

An ACI Standard

Reported by ACI Committee 376



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## **Code Requirements for Design and Construction of Concrete Structures for the Containment of Refrigerated Liquefied Gases and Commentary**

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# Code Requirements for Design and Construction of Concrete Structures for the Containment of Refrigerated Liquefied Gases (ACI 376M-11) and Commentary

An ACI Standard

Reported by ACI Committee 376

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## INTRODUCTION

ACI Committee 376 was formed and subsequently ACI 376-11 was drafted in response to a request from the National Fire Protection Association (NFPA) Technical Committee 59A on liquefied natural gas (LNG). That committee is responsible for NFPA 59A, which is an internationally recognized standard governing the production, storage, and handling of LNG at an operating temperature of  $-168^{\circ}\text{C}$ .

NFPA 59A contains provisions for the use of reinforced concrete and prestressed concrete for two principal applications: 1) impoundment—secondary containment in conjunction with a metallic primary container; and 2) storage—primary containment. NFPA 59A is somewhat limited; it does not provide guidelines specifically tailored to concrete use at cryogenic temperatures. This limitation was the impetus for Committee 59A's request. Although the request was related specifically to containment of LNG, this code addresses concrete use for other refrigerated liquefied gas (RLG) as well, ranging in operating temperatures from  $+4$  to  $-200^{\circ}\text{C}$ . This makes the code and commentary analogous to the American Petroleum Institute's API 620, which governs design and construction of steel and aluminum RLG storage tanks to  $-168^{\circ}\text{C}$ .

The most common use of reinforced concrete and prestressed concrete in cryogenic storage applications is for secondary containment around metal primary storage tanks. Prestressed concrete primary containment tanks were built in North America and Europe from the 1960s through the 1980s. Renewed interest in the use of concrete for primary containment and the need for a code that addressed secondary concrete containment led to the development of this code, which includes pertinent excerpts from ACI 318M-11 and ACI 350M-06. The commentary includes considerations by the committee in developing the code.

The commentary is not intended to provide a complete historical background concerning development of the code, nor is it intended to provide a detailed summary of the studies and research data reviewed by the committee in formulating its provisions. References to specific research

data are provided for more in-depth study of the background materials.

ACI 376M may be used as a part of a legally adopted code and, as such, must differ in form and substance from documents that provide detailed specifications, recommended practice, complete design procedures, or design aids.

Requirements more stringent than the code provisions are desirable for unusual structures. This code and commentary cannot replace sound engineering knowledge, experience, and judgment. A code for design and construction states the minimum requirements necessary to provide for public health and safety. ACI 376M is based on this principle. For any structure, the owner and engineer may require the quality of materials and construction to be higher than the minimum requirements necessary to provide serviceability and to protect the public as stated in the code. Lower standards, however, are not permitted.

ACI 376M has no legal status unless it is adopted by regulatory bodies. Where the code has not been adopted, it may serve as a reference to good practice. The code provides a means of establishing minimum standards for acceptance of design and construction by a legally appointed official or designated representative. The code and commentary are not intended for use in settling disputes between the owner, engineer, contractor, or their agents, subcontractors, material suppliers, or testing agencies. Therefore, the code cannot define the contract responsibility of each of the parties in typical construction. General references requiring compliance with ACI 376M in the job specifications should be avoided because the contractor is rarely in a position to accept responsibility for design details or construction requirements that depend on a detailed knowledge of the design. Generally, the contract documents should contain all of the necessary requirements to ensure compliance with the code. In part, this can be accomplished by reference to specific code sections in the job specifications. Other ACI publications, such as ACI 301M, are written specifically for use as contract documents for construction.