

# **UNIFIED FACILITIES CRITERIA (UFC)**

## **STRUCTURES TO RESIST THE EFFECTS OF ACCIDENTAL EXPLOSIONS**



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**UNIFIED FACILITIES CRITERIA (UFC)****STRUCTURES TO RESIST THE EFFECTS OF ACCIDENTAL EXPLOSIONS**

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U.S. ARMY CORPS OF ENGINEERS

NAVAL FACILITIES ENGINEERING COMMAND (Preparing Activity)

AIR FORCE CIVIL ENGINEER SUPPORT AGENCY

Record of Changes (changes are indicated by \1\ ... /1/)

Change No.	Date	Location

UFC 3-340-02  
5 December 2008

## FOREWORD

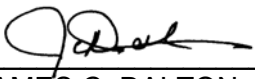
The Unified Facilities Criteria (UFC) system is prescribed by MIL-STD 3007 and provides planning, design, construction, sustainment, restoration, and modernization criteria, and applies to the Military Departments, the Defense Agencies, and the DoD Field Activities in accordance with [USD\(AT&L\) Memorandum](#) dated 29 May 2002. UFC will be used for all DoD projects and work for other customers where appropriate. All construction outside of the United States is also governed by Status of Forces Agreements (SOFA), Host Nation Funded Construction Agreements (HNFA), and in some instances, Bilateral Infrastructure Agreements (BIA.) Therefore, the acquisition team must ensure compliance with the more stringent of the UFC, the SOFA, the HNFA, and the BIA, as applicable.


UFC are living documents and will be periodically reviewed, updated, and made available to users as part of the Services' responsibility for providing technical criteria for military construction. Headquarters, U.S. Army Corps of Engineers (HQUSACE), Naval Facilities Engineering Command (NAVFAC), and Air Force Civil Engineer Support Agency (AFCEA) are responsible for administration of the UFC system. Defense agencies should contact the preparing service for document interpretation and improvements. Technical content of UFC is the responsibility of the cognizant DoD working group. Recommended changes with supporting rationale should be sent to the respective service proponent office by the following electronic form: [Criteria Change Request \(CCR\)](#). The form is also accessible from the Internet sites listed below.


UFC are effective upon issuance and are distributed only in electronic media from the following source:


- Whole Building Design Guide web site <http://dod.wbdg.org/>.

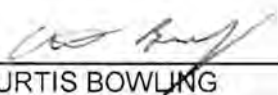
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**UNIFIED FACILITIES CRITERIA (UFC)  
UFC 3-340-02 SUMMARY SHEET****Document:** UFC 3-340-02**Superseding:** ARMY TM 5-1300, Navy NAVFAC P-397, and Air Force AFR 88-22

**Description:** This UFC 3-340-02 presents methods of design for protective construction used in facilities for development, testing, production, storage, maintenance, modification, inspection, demilitarization, and disposal of explosive materials. In so doing, it establishes design procedures and construction techniques whereby propagation of explosion (from one structure or part of a structure to another) or mass detonation can be prevented and personnel and valuable equipment can be protected. This document was previously approved as a tri-service document; Army TM 5-1300, Navy NAVFAC P-397, and Air Force AFR 88-22, dated November 1990. The conversion of the November 1990 document into UFC 3-340-02 was accomplished through the development of a concise navigable Adobe Acrobat format version of the November 1990 document with only very minor revisions dated June 2008.

**Reasons for Document:**

- This document is referenced by DoD 6055.09-STD, "DOD Ammunition and Explosives Safety Standards" and applies to all operations and facilities within an explosives safety quantity-distance (ESQD) arc in which personnel or property are exposed to ammunition and explosives hazards. The document contains design procedures to achieve personnel protection, protect facilities and equipment, and prevent propagation of accidental explosions.

**Impact:** There are no anticipated cost impacts. However, the following benefits should be realized.

- Current Department of Defense design and construction criteria will be incorporated into the Unified Facilities Criteria (UFC).
- The November 1990 document will be available in a more functional format that allows simpler navigation of the document, and will facilitate future update capabilities.

## **UFC 3-340-02, “Structures to Resist the Effects of Accidental Explosions.”**

This document is a conversion and update of Army TM5-1300, Navy NAVFAC P-397, and Air Force AFR 88-22, dated November 1990.

It has been converted into a current Adobe PDF format for ease of navigation.

Three downloadable files are provided.

1. “[ufc\\_3\\_340\\_02\\_pdf.pdf](#)”: This file will allow you to view the complete UFC as a stand alone PDF document.
2. “[ufc\\_3\\_340\\_02\\_dplot\\_v1.zip](#)”: When extracted this application will allow the plots contained within the document to be opened with Dplot pre-version 2.1, to enhance their functionality. You must have Dplot installed on your computer to use this capability. If you have a Dplot version 2.1 or later installed, you should download the file “UFC 3-340-02 DPLOT v2.zip” instead of this one.
3. “[ufc\\_3\\_340\\_02\\_dplot\\_v2.zip](#)”: When extracted this application will allow the plots contained within the document to be opened with Dplot version 2.1 or later, to enhance their functionality. You must have Dplot installed on your computer to use this capability. If you have a Dplot pre-version 2.1 installed, you should download the file “[ufc\\_3\\_340\\_02\\_dplot\\_v1.zip](#)” instead of this one.

Downloadable files: (Please read notes below before proceeding)

1. “[ufc\\_3\\_340\\_02\\_pdf.pdf](#)”: For use in a stand alone mode. (1943 pages, 18.5mb)
2. “[ufc\\_3\\_340\\_02\\_dplot\\_v1.zip](#)”: For use with Dplot (pre version 2.1) (17.5mb)
3. “[ufc\\_3\\_340\\_02\\_dplot\\_v2.zip](#)”: For use with Dplot (v2.1 or later) (19mb)

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### Notes regarding the zipped files:

The UFC has been developed so that the plot files contained in the document can be opened in DPlot to enhance their functionality.

DPlot is a plotting program developed by HydeSoft Computing LLC ([www.dplot.com](http://www.dplot.com)) that allows viewing and editing of a variety of data plots.

After installing the appropriate zipped file, the source DPlot files can be opened when the plot images contained in the PDF version of UFC are clicked.

The two zipped files, representing two versions of the document differ only with regard to DPlot file compatibility.

If the user has an older version of DPlot (pre-2.1), version 1 of this document, “UFC 3-340-02 DPLOT v1.zip”, should be used for compatibility. If the user has a current version of DPlot (v2.1 or later), version 2 of this document, “[ufc\\_3\\_340\\_02\\_dplot\\_v2.zip](#)”, should be used.

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Notes regarding installation:

1. The compressed ZIP file for the document can be uncompressed to any location that the user desires.
2. The "Plots" folder must remain located adjacent to the PDF document for the hyperlinked images to run correctly. That is, the document and the plots folder should be co-located; the document should never be placed within the plots folder. Extracting the zip file to a specified location on your computer should set up the appropriate file structure.

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Notes regarding the Dplot File function:

Errors may occur in attempting to open the hyperlinked plot files if the user has both an older and newer version of DPlot installed. This often based on the "file associations" of the user's computer. In such case, version 2 of the document can be employed if the user re-associates the file extensions.

To re-associate the DPlot file type (\*.grf) with the new version of DPlot, follow these steps:

1. Navigate in windows explorer to a DPlot file
2. Right click on the file, and select "open with" from the drop-down menu
3. Use the "Browse" button to navigate to the Program directory, selecting the "DPLOT.exe" program from the DPlot folder. Select "open" or "OK".
4. After selecting the program, the computer will return to the prior "Open With" dialogue. MAKE sure to check the box for the option to always open files of this type with the DPlot program that you selected.

This procedure will re-associate the chosen version of DPlot to open \*.grf files by default.

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Notes regarding document:

The PDF document features two major navigational systems, either of which may be used to move through the document.

First, the navigation pane on the left side allows the user to jump to various locations in the document. Each chapter can be expanded using the "plus" marker to its left, revealing sub-sections.

Second, the tables of contents, figures, and tables located in the text pages of the document are hyperlinked. Clicking on the text will allow the user to jump immediately to particular sections, images, or tables.

**SUMMARY OF SUBSTANTIVE CHANGES FROM  
Army TM 5-1300, Navy NAVFAC P-397, and Air Force AFR 88-22, dated  
NOVEMBER 1990<sup>1</sup>**

<b>Description</b>	<b>References</b>
Increases maximum design support rotation for non-laced reinforced concrete elements under flexural action to 6-degrees.	Section 4-9.2, Section 4-9.3, Section 4-16, Section 4-23.3, Section 4-24, Section 4-25.1, Section 4-25.3, Section 4-26.1 and Section 4-34
Increases maximum design support rotation for non-laced reinforced concrete elements under tension membrane action to 12-degrees.	Section 4-9.3 and Section 4-25.4
Allows use of ASTM A 706 reinforcing bars in lieu of ASTM A 615 reinforcing bars.	Section 4-12.2
Updates and expands dynamic increase factor data for concrete and reinforcing bars.	Section 4-13.2, Figure 4-9a, Figure 4-9b and Figure 4-10
Revises dynamic design stresses for elements with a maximum design support rotation, $\theta_m$ , $5^\circ < \theta_m \leq 6^\circ$ .	Section 4-13.3 (Table 4-2)
Provides new equations for calculating minimum reinforcement ratios for slabs. Equations now explicitly consider the concrete's compressive strength and the reinforcing bar's yield strength.	Section 4-17.3, Table 4-3, Section 4-33.4.2 and Appendix 4A (Example 4A-1, step 6 and Example 4A-4, step 6)
Adds alternate ACI equation for calculating the allowable shear stress on the unreinforced web of an element subjected to flexure only.	Section 4-18.2
Revises diagonal tension design requirements for slabs that are based upon the scaled charge distance.	Section 4-18.3
Updates minimum design shear stresses. In addition, instead of basing requirements upon close-in and far design ranges, requirements are now based upon the scaled charge distance from an element.	Section 4-18.4 and Table 4-4
Revises the equation for allowable ultimate direct shear force, $V_d$ , that may be resisted by the concrete in a slab.	Section 4-19.2 and Section 4-19.3

Description	References
Adds new sections on tension design requirements in non-laced slabs, laced slabs and beams (previously provided in section 4-68).	Section 4-20A, Section 4-26.3 and Section 4-35A
Significantly revises reinforcing bar development and lap splice requirements. In general, reinforcing bar development and lap splice lengths now calculated in accordance with the provisions of the latest ACI 318 Building Code. Supplementary requirements are noted.	Section 4-21 and subsections, Section 4-64, Section 4-65.3 and Section 4-66 subsections
Significantly expands allowable uses of single leg stirrups for diagonal tension reinforcement in slabs. Provides limits on the use of 3 different single leg stirrup types (designated as Type A, Type B and Type C).	Section 4-22 and Section 4-32
Updates figures summarizing design parameters for unlaced and laced elements to incorporate new criteria.	Figure 4-17 and Figure 4-29
Replaces minimum reinforcement ratio guidance with new equations that explicitly consider the concrete's compressive strength and the reinforcing bar's yield strength.	Section 4-38.3 and Appendix 4A (Example 4A-6, step 4d)
Provides new equations for calculating the minimum area of closed ties in columns.	Section 4-48.4
Provides new equations for calculating the minimum area of spiral reinforcement in columns.	Section 4-49.4
Section completely revised to incorporate UFC 3-340-01's procedures for predicting concrete spall and breach. Since UFC 3-340-01 is a limited distribution document, these open distribution procedures were not previously available to the public.	Section 4-55 (including Figure 4-65, Figure 4-65a and Table 4-15a)
Defines Type A, Type B and Type C single leg stirrups and their allowable uses.	Section 4-66.3.1
Section revised to eliminate now duplicate guidance for non-laced slabs, laced slabs and beams (now provided in Section 4-20A, Section 4-26.3 and Section 4-35A, respectively).	Section 4-68
Figures updated to incorporate changes to design criteria.	Figure 4-1, Figure 4-2, Figure 4-18, Figure 4-21, Figure 4-59, Figure 4-83, Figure 4-85, Figure 4-101, Figure 4-102 and Figure 4-103



Description	References
Updates and expands bibliography.	Appendix 4C

<sup>1</sup>All substantive changes were made to chapter 4, Reinforced Concrete Design.