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USACE / NAVFAC / AFCEA / NASA UFGS-21 21 00.00 40 (August 2010)  
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Preparing Activity: NASA Superseding  
UFGS-21 21 00.00 40 (August 2008)

## UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2010

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#### SECTION 21 21 00.00 40

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08/10

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SECTION 21 21 00.00 40

### CARBON-DIOXIDE FIRE-EXTINGUISHING SYSTEMS 08/10

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NOTE: This specification covers the requirements  
for carbon dioxide fire-protection systems.

Indicate protected spaces and affected equipment on  
the drawings.

Edit this guide specification for project specific  
requirements by adding, deleting, or revising text.  
For bracketed items, choose applicable items(s) or  
insert appropriate information.

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

Comments and suggestions on this guide specification  
are welcome and should be directed to the technical  
proponent of the specification. A listing of  
technical proponents, including their organization  
designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as  
a Criteria Change Request (CCR).

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## PART 1 GENERAL

### 1.1 REFERENCES

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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 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.

\*\*\*\*\*

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

ASME INTERNATIONAL (ASME)

ASME B36.10M (2004; R 2010) Standard for Welded and Seamless Wrought Steel Pipe

ASTM INTERNATIONAL (ASTM)

ASTM A 106/A 106M (2008) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service

ASTM A 53/A 53M (2007) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM B 88 (2009) Standard Specification for Seamless Copper Water Tube

ASTM B 88M (2005) Standard Specification for Seamless Copper Water Tube (Metric)

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58 (2009) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

MSS SP-69 (2003) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

RCBEA GUIDE (2004) NASA Reliability Centered Building and Equipment Acceptance Guide

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 12 (2008) Standard on Carbon Dioxide Extinguishing Systems

NFPA 72 (2010; TIA 10-1; TIA 10-2; TIA 10-3; TIA 10-4) National Fire Alarm and Signaling Code

## 1.2 SYSTEM DESCRIPTION

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NOTE: If Section 23 00 00 AIR SUPPLY, DISTRIBUTION,  
VENTILATION, AND EXHAUST SYSTEMS is not included in  
the project specification, applicable requirements  
should be inserted and the following paragraph  
deleted.  
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[ Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS  
applies to work specified in this section.  
]

### 1.2.1 Design Requirements

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NOTE: Modify the following paragraph to suit  
project requirements.  
\*\*\*\*\*

Give full consideration to built-in spaces, piping, electrical equipment,  
ductwork, and all other construction and equipment. Ensure system is free  
from operating and maintenance difficulties.

Provide devices and equipment of a make and type listed by the Underwriters  
Laboratories, (UL), or FM Global (FM) approved. In the UL and FM  
publications, the advisory provisions are considered to be mandatory.  
Interpret reference to the "authority having jurisdiction" to mean the  
Contracting Officer.

\*\*\*\*\*  
NOTE: Select system type.  
\*\*\*\*\*

Provide an approved high-pressure carbon dioxide [hand] [hose] [reel] total  
flooding type system conforming to NFPA 12.

Ensure electrical work associated with the system meets the requirements of  
the appropriate electrical sections pertaining to fire detection.

\*\*\*\*\*  
NOTE: Section 23 05 48 VIBRATION AND SEISMIC  
CONTROLS FOR HVAC PIPING AND EQUIPMENT may be used  
as a guide for vibration isolation.  
\*\*\*\*\*

### 1.2.2 Performance Requirements

\*\*\*\*\*  
NOTE: Discharge of carbon dioxide into an enclosed  
space creates a dangerous oxygen deficiency for  
personnel. Dilution of oxygen in the air by the  
carbon dioxide concentrations necessary to  
extinguish the fire will create atmosphere that will  
not sustain life.  
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Provide carbon dioxide supplied from 25-, 40-, 50-kilogram 50-, 75-, or 100-pound high-pressure cylinders stored in rechargeable containers designed to hold pressurized carbon dioxide in liquid form at atmospheric temperatures corresponding to a normal pressure of 5860 kilopascal at 21 degrees C 850 pounds per square inch (psi) at 70 degrees F.

Provide high-pressure cylinders constructed, tested, and marked in accordance with U.S. Department of Transportation specifications for seamless steel cylinders.

Provide each cylinder with a safety device to relieve excess pressure safely, in advance of the rated cylinder test pressure. Ensure devices are Interstate Commerce Commission approved frangible safety disks.

Support carbon dioxide cylinders by suitable racks attached to walls and floor. Provide cylinder framing fitted with a weighing bar bracket, weight bar, and direct-reading scale to weigh cylinders in place without deactivating the system.

Arrange system for fully automatic, manually operated, and remote-pushbutton electric control operation. Provide enclosed release type operating controls to prevent accidental operation.

### 1.3 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation 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.

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

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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation 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

Installation Drawings

Connection Diagrams

SD-03 Product Data

Equipment Foundation Data

Carbon Dioxide Cylinders

Piping Materials

SD-05 Design Data

Design Analysis and Calculations

SD-06 Test Reports

Pressure Tests

System Tests

Impedance Test

Request for Inspection and Test

SD-07 Certificates

Listing of Product Installation

Certificates of Conformance

Piping Materials

High-Pressure Cylinders

Escutcheons

Supporting Elements

SD-08 Manufacturer's Instructions

Operating Instructions

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals

## 1.4 ADMINISTRATIVE REQUIREMENTS

### 1.4.1 Pre-Installation Requirements

Prior to the commencement of work, submit [installation drawings](#) conforming to [NFPA 12](#), to the Contracting Officer for review and approval, including [connection diagrams](#) indicating the relations and connections of the following items:

- a. Carbon Dioxide Cylinders
- b. Piping Materials

Indicate on drawings the general physical layout of all controls, and internal tubing and wiring details. Submit [design analysis and calculations](#) with drawings. Include with drawings all [equipment foundation data](#) for carbon dioxide fire-protection systems consisting of the following information:

- a. Equipment weight and operating loads.
- b. Horizontal and vertical loads.
- c. Size, location, and projection of anchor bolts.
- d. Horizontal and vertical clearances for installation, operation and maintenance.
- e. Plan dimensions of foundations and relative elevations.
- f. Installation requirements such as noise abatement, vibration isolation, and utility service.

## 1.5 QUALITY ASSURANCE

### 1.5.1 Qualification and Regulatory Requirements

Submit [listing of product installation](#) carbon dioxide fire-protection systems showing at least 5 installed units, similar to those proposed, that have been in successful service for a minimum period of 5 years. Include purchaser, address of installation, service organization, and date of installation.

Also submit [certificates of conformance](#) verifying conformance with the standards referenced in this specification for the following:

- a. Piping Materials
- b. High-Pressure Cylinders
- c. Escutcheons
- d. Supporting Elements

### 1.5.2 Predictive Testing And Inspection Technology Requirements

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**NOTE: The Predictive Testing and Inspection (PT&I)  
tests prescribed in Section 01 86 12.07 40**



RELIABILITY CENTERED ACCEPTANCE FOR MECHANICAL SYSTEMS are MANDATORY for all [NASA] [\_\_\_\_\_] assets and systems identified as Critical, Configured, or Mission Essential. If the system is non-critical, non-configured, and not mission essential, use sound engineering discretion to assess the value of adding these additional test and acceptance requirements. See Section 01 86 12.07 40 RELIABILITY CENTERED ACCEPTANCE FOR MECHANICAL SYSTEMS for additional information regarding cost feasibility of PT&I.

\*\*\*\*\*

This section contains systems and/or equipment components regulated by NASA's Reliability Centered Building and Equipment Acceptance Program. This program requires the use of Predictive Testing and Inspection (PT&I) technologies in conformance with RCBEA GUIDE to ensure building equipment and systems installed by the Contractor have been installed properly and contain no identifiable defects that shorten the design life of a system and/or its components. Satisfactory completion of all acceptance requirements is required to obtain Government approval and acceptance of the Contractor's work.

Perform PT&I tests and provide submittals as specified in Section 01 86 12.07 40 RELIABILITY CENTERED ACCEPTANCE FOR MECHANICAL SYSTEMS.

## PART 2 PRODUCTS

### 2.1 EQUIPMENT

Provide only UL-listed or FM-approved equipment and devices in the systems.

Design the system and construct to include a fixed supply of carbon dioxide cylinders connected to properly sized, fixed piping with fittings and nozzles to direct this agent into an enclosure surrounding the hazard.

### 2.2 COMPONENTS

#### 2.2.1 Piping

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**NOTE: Revise the following paragraph to suit project requirements.**  
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Provide galvanized, ferrous piping, Schedule [40] [80], manifolds and distribution piping materials, conforming to [ASTM A 53/A 53M] [ASTM A 106/A 106M] [ASME B36.10M]. Also provide nonferrous drawn seamless copper tubing conforming to ASTM B 88M ASTM B 88, and flexible metallic hose conforming to UL 536.

Reduce pipe sizes in the fitting. Flush bushings are not allowed. When used, fuse brazed joints with an alloy having a melting point above 538 degrees C 1,000 degrees F.

Provide pipe and fittings having a minimum bursting pressure of 34.5 Megapascal 5,000 psi. Provide schedule 40 for DN15 and DN20 1/2-inch and 3/4-inch iron pipe size (ips). Provide schedule 80 for DN25 1 inch or greater. Use standard malleable iron banded fittings or ductile iron fittings up through DN20 3/4-inch ips. Use extra heavy malleable iron or

ductile iron fittings through DN50 2-inch ips. Use forged steel fittings in all sizes over DN50 2 inches.

Install a dirt trap (leg) consisting of a tee with a capped nipple, at least 50 millimeter 2 inches long, at the end of each pipe run.

Use baffle-type nozzles for distribution in normal total flooding systems. Install strainers ahead of small-orifice nozzles to prevent clogging.

Permanently mark discharge nozzles to identify the nozzle and to show the equivalent single orifice diameter regardless of shape and number of orifices.

Conceal piping to the maximum extent possible. Inspect, test, and secure approval before concealing pipe.

Use pipe cement and oil, or graphite and oil for pipe thread joint compound.

Provide pipe hangers and supports conforming to MSS SP-58 and MSS SP-69, adjustable type, zinc-coated. Maximum spacing is as follows:

Nominal Pipe Size (DN)	Maximum Spacing (millimeter)
15 and under	2130
32	2440
40	2740
50	3050
65	3350
80	3660
90	3960
100	4270
125	4570
150	4880

Nominal Pipe Size (inches)	Maximum Spacing (feet)
1 and under	7
1.25	8
1.5	9
2	10
2.5	11
3	12

Nominal Pipe Size (inches)	Maximum Spacing (feet)
3.5	13
4	14
5	15
6	16

#### 2.2.2 Pipe Sleeves

Provide pipe sleeves where piping passes through masonry or concrete walls, floors, roofs, and partitions. Provide schedule 40 zinc-coated steel pipe sleeves in outside walls below and above grade, in floor, or in roof slabs. Provide zinc-coated sheet steel sleeves in partitions having a nominal weight of not less than 4.4 kilogram per square meter 0.90 pound per square foot. Ensure space between piping and the sleeve is not less than 6 millimeter 0.25 inch. Securely place sleeves in proper position and location during construction. Ensure sleeves are of sufficient length to pass through the entire thickness of walls, partitions, or slabs. Ensure sleeves extend 5.08 cm 2 inches above finished floor slabs. Pack space between the pipe and sleeve with insulation and calk both ends of the sleeve with plastic waterproof cement.

#### 2.2.3 Escutcheons

Provide approved one-piece or split-type escutcheons for piping passing through floors, walls, ceilings, and, where pipe passes through finished ceilings, chrome-plated. Provide steel or cast-iron with aluminum finish paint for all other escutcheons. Set and securely fasten escutcheons in place with setscrews or other positive means.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Install materials and equipment in accordance with NFPA 12.

Provide each system complete and ready for operation.

Provide each system with an approved pressure-relief device designed to operate between 20 Megapascal 2,400 and 3,000 psi and located between the storage cylinder manifolds and any normally close valve.

##### 3.1.1 System Control

##### 3.1.1.1 Controls

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**NOTE: Select control type.**  
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Provide [manual] [combination] [electric] [pneumatic] [mechanical pull cable] actuating control system.

#### 3.1.1.2 Control Stations for Underfloor Flooding Systems

Provide actuation stations for underfloor flooding systems at the principal exits from the protected area. Provide a separate actuation station for both the main supply and reserve supply of carbon dioxide at each location.

#### 3.1.1.3 Pressure-Operated Fire Alarm Switch

Provide a pressure-operated switch to actuate the building interior fire alarm system upon the discharge of gas into the carbon dioxide system piping for each separate system.

#### 3.1.1.4 Pressure-Operated Equipment Switch

Provide a pressure-operated switch to automatically shut down the air handling equipment serving the protected space upon the discharge of gas into the carbon dioxide system piping for each separate system.

#### 3.1.1.5 Control Panel

Provide a means for complete electrical supervision of actuating circuitry, in a modular type panel, flush- or surface-mounted steel cabinet with hinged door and cylinder lock. Ensure control panel is neat, compact, and factory-wired containing the parts and equipment required to provide specified operating and supervisory functions of the system. If a ground fault condition occurs preventing the required operation of the system, or a single break in any of the actuating circuits, or loss of ac power, provide for the activation of a system trouble bell, which sounds continuously until the system has been restored to normal at the control panel. Provide a silencing switch to transfer the trouble signals to an indicating lamp in accordance with NFPA 72.

In addition to the normal system trouble bell, provide a remote 100 millimeter, 4-inch, system trouble bell together with a rigid plastic or metal identification sign that reads CARBON DIOXIDE SYSTEM TROUBLE. Minimum lettering height is 25 millimeter 1 inch high.

### 3.1.2 System Power

#### 3.1.2.1 Primary Supply

Provide 120-volt, 60-hertz service, system power, transformed through a two-winding isolation-type transformer and rectified to 24 volts dc for operating trouble signal and actuating circuits. Provide a secondary dc power supply for operation of the system if the ac power fails. Ensure transfer from normal to emergency power or restoration from emergency to normal power is fully automatic. Locate trouble lights on the door of the cabinet. Locate a 100 millimeter 4-inch trouble bell above the top of the cabinet. Finish cabinet on the inside and outside in red enamel with prominent rigid plastic or metal identification plates attached.

#### 3.1.2.2 Secondary Supply

Provide secondary power supply including [nickel cadmium] [lead calcium] [sealed lead acid] batteries and charger. Dry cell batteries are not acceptable. Ensure batteries are housed in a well-constructed steel cabinet with cylinder lock.

### 3.1.2.3 Storage Batteries

Provide batteries with proper ampere-hour capacity to operate the system under supervisory conditions for up to 60 hours, with calculations substantiating the battery capacity.

### 3.1.2.4 Battery Charger

Provide battery charger with completely automatic high/low charging rate capable of recovery of the batteries from full discharge to full charge in 24 hours or less. Include an ammeter showing rate of charge and a voltmeter to indicate state of battery charge, with a red pilot light indicating when batteries are manually placed on a high rate of charge, if a high-rate switch is provided.

### 3.1.3 Electrical Work

\*\*\*\*\*  
**NOTE: Insert the appropriate Fire Detection and Alarm system for your project in the following paragraph if other than as shown in the first set of brackets.**  
\*\*\*\*\*

Electrical work is specified in Section [28 31 13.00 40 FIRE DETECTION AND ALARM CONTROL, GUI, AND LOGIC SYSTEMS] [\_\_\_\_\_].

### 3.1.4 Operating Instructions

Provide operating instructions at each remote control station, clearly indicating the necessary steps for the operation of the system.

Submit [6] [\_\_\_\_\_] copies of the [operation and maintenance manuals](#) [30] [\_\_\_\_\_] calendar days prior to testing the carbon dioxide fire-protection systems. Update and resubmit data for final approval no later than [30] [\_\_\_\_\_] calendar days prior to contract completion.

Submit [operating instructions](#) for carbon dioxide fire-protection systems, consisting of raised or embossed white letters on red rigid plastic or enameled steel background, and of adequate size to permit them to be easily read.

### 3.1.5 Field Painting

Provide painting of the system in accordance with Section [09 90 00 PAINTS AND COATINGS](#).

## 3.2 FIELD QUALITY CONTROL

Conduct testing to determine conformance with the requirements in the presence of the Contracting Officer.

### 3.2.1 Preliminary Tests

Perform and record [pressure tests](#) and [system tests](#).

Test each piping system pneumatically at [1050 kilopascal 150 pounds per square inch gage](#) and verify no leakage or reduction in gage pressure after 2 hours occurs. Upon completion and before final acceptance of the work,

test each piping system by discharging a minimum of one 34 kilogram 75-pound high-pressure cylinders of carbon dioxide to demonstrate the reliability and proper functioning of pressure-operated switches and the discharge of carbon dioxide gas from each system discharge nozzle.

Test all remote control stations, and all other components, supporting elements and accessories individually to demonstrate proper functioning.

On all storage batteries, perform an impedance test of each cell, record the results, and use as baselines.

Provide test results to the Contracting Officer. Submit the test results with a cover letter/sheet clearly marked with the System name, date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

At the completion of tests and corrections, submit a signed and dated certificate to the Contracting Officer attesting to the satisfactory completion of all testing and that the system is in operating condition.

Submit a written request for inspection and test to the Contracting Officer for carbon dioxide fire-protection systems formal tests.

### 3.2.2 Formal Tests

```
*****
NOTE:  If the specified system is identified as
critical, configured, or mission essential, use
Section 01 86 12.07 40 RELIABILITY CENTERED
ACCEPTANCE FOR MECHANICAL SYSTEMS to establish
predictive and acceptance testing criteria.
*****
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Perform PT&I tests and provide submittals as specified in Section 01 86 12.07 40 RELIABILITY CENTERED ACCEPTANCE FOR MECHANICAL SYSTEMS.

At a time to which the Government has agreed, the Government Fire Protection Engineer will witness formal tests and approve systems before they are accepted. Ensure an experienced technician regularly employed by the system installer is present during the inspection. At this inspection, repeat any or all of the required tests as directed by the Contracting Officer. Furnish carbon dioxide, instruments, personnel, appliances, and equipment for testing at no cost to the Government.

### [3.2.3 Manufacturer's Representative

Make provisions for an experienced manufacturer's field engineer to supervise installation and testing of the system.

] -- End of Section --