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

## UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2009

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#### SECTION 21 21 00.00 40

#### CARBON-DIOXIDE FIRE-EXTINGUISHING SYSTEMS

08/08

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### SECTION 21 21 00.00 40

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

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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.

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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) 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 (2003) 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 (2002) Standard for Pipe Hangers and Supports - Materials, Design and Manufacture

MSS SP-69 (2003; R 2004) Standard for Pipe Hangers and Supports - Selection and Application

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 12 (2007) Standard on Carbon Dioxide Extinguishing Systems

NFPA 72 (2006) National Fire Alarm Code

UNDERWRITERS LABORATORIES (UL)

UL 536 (1997; Rev thru Jun 2003) Standard for Flexible Metallic Hose

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 therefrom 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.

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Full consideration shall be given to built-in spaces, piping, electrical equipment, ductwork, and all other construction and equipment. System shall be free from operating and maintenance difficulties.

Devices and equipment shall be a make and type listed by the Underwriters Laboratories, (UL), or FM Global (FM) approved. In the UL and FM publications, the advisory provisions shall be considered to be mandatory. Reference to the "authority having jurisdiction" shall be interpreted to mean the Contracting Officer.

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NOTE: Select system type.

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

Electrical work associated with the system shall meet the requirements of the appropriate sections of Division 16, "Electrical," pertaining to fire detection.

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

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#### 1.2.2 Performance Requirements

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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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Carbon dioxide shall be supplied from 25-, 40-, 50-kilogram 50-, 75-, or 100-pound high-pressure cylinders and shall be 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.

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

Each cylinder shall be provided with a safety device to relieve excess pressure safely, in advance of the rated cylinder test pressure. Devices shall be Interstate Commerce Commission approved frangible safety disks.

Carbon dioxide cylinders shall be supported by suitable racks attached to walls and floor. Cylinder framing shall be fitted with a weighing bar bracket, weight bar, and direct-reading scale to weigh cylinders in place without deactivating the system.

System shall be arranged for fully automatic, manually operated, and remote-pushbutton electric control operation. Operating controls shall be the enclosed release type 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

Connection diagrams shall be submitted indicating the relations and connections of the following items. Drawings shall indicate the general physical layout of all controls, and internal tubing and wiring details.

Carbon Dioxide Cylinders  
Piping Materials

Installation Drawings shall be submitted in accordance with paragraph entitled, "General," of this section.

#### SD-03 Product Data

Equipment Foundation Data shall be submitted in accordance with paragraph entitled, "General," of this section.

#### SD-05 Design Data

Design Analysis and Calculations shall be submitted in accordance with paragraph entitled, "General," of this section.

#### SD-06 Test Reports

Test reports shall be submitted for the following tests in accordance with the paragraph entitled, "Field Testing," of this section.

Pressure Tests  
System Tests  
Impedance Test

Request for Inspection and Test shall be submitted in accordance with paragraph entitled, "Preliminary Tests," of this section.

#### SD-07 Certificates

Listing of Product Installation shall be submitted for carbon dioxide fire-protection systems in accordance with paragraph entitled, "Installation," of this section.

Certificates shall be submitted for the following items showing conformance with the referenced standards contained in this section.

Piping Materials  
High-Pressure Cylinders  
Escutcheons  
Supporting Elements

#### SD-08 Manufacturer's Instructions

Operating Instructions shall be submitted in accordance with paragraph entitled, "Operating Instructions," of this section.

## SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted in accordance with paragraph entitled, "Operating Instructions," of this section.

### 1.4 GENERAL

Equipment Foundation Data shall be submitted for carbon dioxide fire-protection systems consisting of the following information:

Equipment weight and operating loads.

Horizontal and vertical loads.

Size, location, and projection of anchor bolts.

Horizontal and vertical clearances for installation, operation and maintenance.

Plan dimensions of foundations and relative elevations.

Installation requirements such as noise abatement, vibration isolation, and utility service.

Installation Drawings shall be submitted for carbon dioxide fire-protection systems in accordance with the requirements of NFPA 12. Drawings shall include details of equipment layout and design.

Design Analysis and Calculations shall be submitted for carbon dioxide fire-protection systems including spray areas, hazard by class, and pressure calculations.

## PART 2 PRODUCTS

### 2.1 EQUIPMENT

Only UL-listed or FM-approved equipment and devices shall be used in the systems.

System shall be designed and constructed 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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Manifolds and distribution piping materials shall be galvanized, ferrous piping, Schedule [40] [80], conforming to [ASTM A 53/A 53M] [ASTM A 106/A 106M] [ASME B36.10M]. Nonferrous drawn seamless copper tubing shall conform to ASTM B 88M ASTM B 88. Flexible metallic hose shall conform to UL 536.

Pipe sizes shall be reduced in the fitting. Flush bushings shall not be used. Brazed joints, when used, shall be fused with an alloy with a melting point above 538 degrees C 1,000 degrees F.

Pipe and fittings shall have a minimum bursting pressure of 34.5 Megapascal 5,000 psi. For DN15 and DN20 1/2-inch and 3/4-inch iron pipe size (ips), the pipe shall be Schedule 40. For DN25 1 inch or greater, the pipe shall be Schedule 80. Standard malleable iron banded fittings or ductile iron fittings shall be used up through DN20 3/4-inch ips. Extra heavy malleable iron or ductile iron fittings shall be used through DN50 2-inch ips. Forged steel fittings shall be used in all sizes over DN50 2 inches.

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

Baffle-type nozzles shall be used for distribution in normal total flooding systems. Strainers shall be installed ahead of small-orifice nozzles to prevent clogging.

Discharge nozzles shall be permanently marked to identify the nozzle and to show the equivalent single orifice diameter regardless of shape and number of orifices.

Piping shall be concealed to the maximum extent possible. Piping shall be inspected, tested, and approved before being concealed.

Joint compound for pipe threads shall be pipe cement and oil or graphite and oil.

Pipe hangers and supports shall be MSS SP-58 and MSS SP-69, adjustable type, zinc-coated. Spacing shall be 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

<u>Nominal Pipe Size (inches)</u>	<u>Maximum Spacing (feet)</u>
1.25	8
1.5	9
2	10
2.5	11
3	12
3.5	13
4	14
5	15
6	16

#### 2.2.2 Pipe Sleeves

Pipe sleeves shall be provided where piping passes through masonry or concrete walls, floors, roofs, and partitions. Sleeves in outside walls below and above grade, in floor, or in roof slabs, shall be Schedule 40 zinc-coated steel pipe. Sleeves in partitions shall be zinc-coated sheet steel having a nominal weight of not less than 4.4 kilogram per square meter 0.90 pound per square foot. Space between piping and the sleeve shall be not less than 6 millimeter 0.25 inch. Sleeves shall be placed securely in proper position and location during construction. Sleeves shall be of sufficient length to pass through the entire thickness of walls, partitions, or slabs. Sleeves shall extend 50 millimeter 2 inches above finished floor slabs. Space between the pipe and sleeve shall be packed with insulation and both ends of the sleeve shall be calked with plastic waterproof cement.

#### 2.2.3 Escutcheons

Approved-type escutcheons shall be provided for piping passing through floors, walls, and ceilings. Escutcheons shall be one-piece or split-type and, where pipe passes through finished ceilings, shall be chrome-plated. Other escutcheons shall be of steel or cast iron, with aluminum paint finish. Escutcheons shall be securely fastened in place with setscrews or other positive means.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Materials and equipment shall be installed in accordance with NFPA 12.

Each system shall be provided complete and ready for operation.

Each system shall be provided 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.

Listing of Product Installation shall be submitted for 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. List shall include purchaser, address of installation, service organization, and date of installation.

### 3.1.1 System Control

#### 3.1.1.1 Controls

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**NOTE: Select control type.**  
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Actuating control system shall be [manual] [combination] [electric] [pneumatic] [mechanical pull cable].

#### 3.1.1.2 Control Stations for Underfloor Flooding Systems

Actuation stations for underfloor flooding systems shall be provided at the principal exits from the protected area. A separate actuation shall be provided for the main supply and reserve supply of carbon dioxide at each location.

#### 3.1.1.3 Pressure-Operated Fire Alarm Switch

A pressure-operated switch shall be provided 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

A pressure-operated switch shall be provided 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

Means shall be provided for complete electrical supervision of actuating circuitry. A modular type panel in a flush- or surface-mounted steel cabinet with hinged door and cylinder lock shall be installed. Control panel shall be a neat, compact, factory-wired assembly containing the parts and equipment required to provide specified operating and supervisory functions of the system. A ground fault condition that prevents the required operation of the system or a single break in any of the actuating circuits shall result in the activation of a system trouble bell. Loss of ac power shall also result in the operation of the system trouble bell. Trouble bell shall sound continuously until the system has been restored to normal at the control panel. A silencing switch shall be provided to transfer the trouble signals to an indicating lamp in accordance with NFPA 72.

In addition to the normal system trouble bell, a remote 100 millimeter, 4-inch, system trouble bell shall be provided together with a rigid plastic or metal identification sign that reads CARBON DIOXIDE SYSTEM TROUBLE. Lettering shall be a minimum of 25 millimeter 1 inch high.

### 3.1.2 System Power

#### 3.1.2.1 Primary Supply

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

#### 3.1.2.2 Secondary Supply

Secondary power supply shall include [nickel cadmium] [lead calcium] [sealed lead acid] batteries and charger. Dry cell batteries shall not be used. Batteries shall be housed in a well-constructed steel cabinet with cylinder lock.

#### 3.1.2.3 Storage Batteries

Batteries shall be of the proper ampere-hour capacity to operate the system under supervisory conditions for up to 60 hours. Calculations substantiating the battery capacity shall be provided.

#### 3.1.2.4 Battery Charger

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

### 3.1.3 Electrical Work

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

Operating instructions shall be provided at each remote control station. Instructions shall clearly indicate necessary steps for the operation of the system.

Contractor shall submit [6] [\_\_\_\_\_] copies of the [Operation and Maintenance Manuals](#) 30 calendar days prior to testing the carbon dioxide fire-protection systems. Data shall be updated and resubmitted for final approval no later than 30 calendar days prior to contract completion.

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

### 3.1.5 Field Painting

Painting of the system shall be in accordance with Section 09 90 00.00 40 PAINTING AND COATING.

### 3.2 FIELD QUALITY CONTROL

Testing to determine conformance with the requirements shall be conducted in the presence of the Contracting Officer.

#### 3.2.1 Preliminary Tests

Pressure tests and system tests shall be performed and recorded.

Each piping system shall be tested pneumatically at 1050 kilopascal 150 pounds per square inch gage and shall show no leakage or reduction in gage pressure after 2 hours. Upon completion and before final acceptance of the work, each piping system shall be tested 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. Remote control stations, and all other components, supporting elements and accessories shall be tested individually to demonstrate proper functioning.

Storage batteries shall be given an impedance test of each cell and the results recorded to be used as baselines. Test results shall be provided to the Contracting Officer. Test results shall have 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, a signed and dated certificate shall be submitted to the Contracting Officer attesting to the satisfactory completion of all testing and that the system is in operating condition.

A written Request for Inspection and Test shall be submitted to the Contracting Officer for carbon dioxide fire-protection systems.

#### 3.2.2 Formal Tests

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. An experienced technician regularly employed by the system installer shall be present during the inspection. At this inspection any or all of the required tests shall be repeated as directed by the Contracting Officer. Carbon dioxide, instruments, personnel, appliances, and equipment for testing shall be furnished by the Contractor at his expense.

#### 3.2.3 Manufacturer's Representative

An experienced manufacturer's field engineer shall be provided to supervise installation and testing of the system.

-- End of Section --