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USACE / NAVFAC / AFCEC **UFGS-21 21 01 (May 2024)**

Preparing Activity: USACE

Superseding
UFGS-21 21 01.00 20 (November 2009)
UFGS-21 02.00 20 (November 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2024

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CARBON-DIOXIDE FIRE-EXTINGUISHING SYSTEMS

05/24

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SECTION 21 21 01

CARBON-DIOXIDE FIRE-EXTINGUISHING SYSTEMS
05/24

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NOTE: This guide specification covers the requirements for high-pressure and low-pressure carbon-dioxide fire-extinguishing systems.

Adhere to UFC 1-300-02: UNIFIED FACILITIES GUIDE SPECIFICATIONS (UFGS) FORMAT STANDARD when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

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

Comments, suggestions, and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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NOTE: Ensure that system requirements conform to UFC 3-600-01: FIRE PROTECTION ENGINEERING FOR FACILITIES and NFPA 12: STANDARD ON CARBON DIOXIDE EXTINGUISHING SYSTEMS. A concerted effort was put forth to ensure that requirements from NFPA 12 were not repeated within this UFGS section. NFPA 12 includes many specific requirements for designing, installing, and operating carbon-dioxide fire-extinguishing systems. Carefully review and comply with the requirements of NFPA 12.

****

****

NOTE: If the total carbon-dioxide capacity required, including reserves, does not exceed 908

kilograms (kg) 2,000 pounds, design a high-pressure carbon-dioxide fire-extinguishing system.

****

NOTE: Do not specify total flooding carbon-dioxide fire-extinguishing systems for use in normally occupied spaces. In other spaces, consider the possibility that personnel could be trapped in an untenable atmosphere created by the discharge or migration of carbon-dioxide. Provide keyed inhibit switches, lockout valves, and audible and visual pre-discharge signals in the design. Provide a sufficient time delay between activation of pre-discharge signals and agent release to allow for evacuation prior to discharge under worst case conditions. Refer to the safety cautions in NFPA 12. If there are questions concerning system design, consult with the Government's Designated (or Service) Fire Protection Engineer (DFPE).

****

NOTE: Indicate at least the following on the Contract Drawings:

1. Locations and types of storage tank(s) or cylinders, manual release stations, releasing service fire alarm control units, and associated connections.

2. The arrangement and location of zone selector valves.

****

NOTE: Tailoring options are used throughout this Section to differentiate between High Pressure System specific requirements and Low Pressure System specific requirements. To ensure that all applicable requirements are included in the edited Section, select either "HIGH-PRESSURE" or "LOW-PRESSURE" tailoring, as appropriate for the project. Do not leave both options unselected, and do not select both options.

****

NOTE: Tailoring options are used throughout this Section to differentiate between Army specific requirements and those requirements applicable to all other entities. To ensure that all applicable requirements are included in the edited Section, select either "ARMY" or "NON-ARMY" tailoring, as appropriate for the project. Do not leave both options unselected, and do not select both options.

****

PART 1 GENERAL

1.1 REFERENCES

****

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 Reference Identifier (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.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.1	(2022) Power Piping

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

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

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-127	(2014; Rev A) Bracing for Piping Systems: Seismic-Wind-Dynamic Design, Selection, and Application

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 4	(2018) Standard for Integrated Fire Protection and Life Safety System Testing

NFPA 12	(2022) Standard on Carbon Dioxide Extinguishing Systems
NFPA 13	(2022; TIA 24-1) Standard for the Installation of Sprinkler Systems
NFPA 70	(2023) National Electrical Code
NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code
NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 170	(2024; ERTA 1 2023) Standard for Fire Safety and Emergency Symbols

UNDERWRITERS LABORATORIES (UL)

UL Fire Prot Dir	UL Product IQ (updated online) at https://productiq.ulpropsector.com/en

1.2 SYSTEM DESCRIPTION

****
NOTE: Identify the rooms, spaces, areas, or pieces of equipment, which are to be protected by each system.
****
****
NOTE: Coordinate with the structural engineer to establish the seismic design category for this project.
****
****
NOTE: Tailoring options have been used in this paragraph to differentiate requirements between low-pressure and high-pressure systems.
****

Provide[a] high-pressure[total flooding][local application] carbon-dioxide fire-extinguishing system(s) for protection of [the areas indicated on the Contract Drawings][_____].Provide[a] low-pressure[total flooding][local application] carbon-dioxide fire-extinguishing system(s) for protection of [the areas indicated on the Contract Drawings][_____].[Include protection of areas beneath raised floors in the system design.] Provide piping offsets, fittings, and any other accessories as required to provide a complete and usable system and to eliminate interference with other construction.

Design any portions of the fire-extinguishing system that are not indicated on the Contract Drawings, including but not limited to locating and sizing nozzles, piping, tanks, pressure switches, valves, and equipment. Design any portions of the releasing system that are not indicated on the Contract Drawings, including but not limited to locating initiating devices, notification appliances, inhibit switches, terminal cabinets, raceways, and pathways.[Provide seismic bracing appropriate for the seismic design category and short-period spectral acceleration value applicable to the project.]

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES (or the particular specification section for submittal procedures in this project) and edit the following list and corresponding submittal items in the text to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed and approved by the Contractor's Quality Control System, and only submitted to the Government for reference. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification with a code of up to three characters 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 Non-Army projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Provide all submittals to the Government, whether for approval or surveillance. Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification require Contractor Quality Control approval and are submitted to the Government for surveillance purposes. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualified Fire Protection Engineer's Qualifications; G, [_____]

Installer's Qualifications; G, [_____]

Supervisor's Qualifications; G, [_____]

Designer's Qualifications; G, [_____]

SD-02 Shop Drawings

Shop Drawings; G, [_____]

SD-03 Product Data

Carbon-Dioxide Supply; G, [_____]

Pipe and Fittings; G, [_____]

Piping Accessories; G, [_____]

Manual Release Stations; G, [_____]

Inhibit Switches; G, [_____]

Discharge Pressure Switches; G, [_____]

Alarm Notification Appliances; G, [_____]

Operating Instructions; G, [_____]

Signs; G, [_____]

SD-05 Design Data

Carbon-Dioxide Supply Calculations; G, [_____]

Pipe and Orifice Sizing Calculations; G, [_____]

Seismic Bracing Calculations; G, [_____]

SD-06 Test Reports

Site Observation Report(s)

Test Procedures; G, [_____]

Request for Formal Inspection and Tests; G, [_____]

Final Test Report; G, [_____]

SD-10 Operation and Maintenance Data

Operation And Maintenance Instructions; G, [_____]

SD-11 Closeout Submittals

Special Tools

Spare Parts Data

Spare Parts

As-Built Drawings; G, [_____]

Recordings

1.4 SUBMITTAL REQUIREMENTS

****
NOTE: Review Section 01 33 00 SUBMITTAL PROCEDURES (or the particular specification section for submittal procedures in this project) to ensure specific quantities and formats of submittals are included therein as desired. Coordinate with the DFPE and Contracting Officer on required quantities and formats to be provided.
****

Provide submittals in quantities, formats, and transmission means as dictated by Section 01 33 00 SUBMITTAL PROCEDURES. Draw floor plans to a scale no less than 1:100 1/8 inch equals one foot. Utilize NFPA 170 compliant symbols.

Submit Shop Drawings (SD-02), Product Data (SD-03), and Calculations (SD-05) simultaneously. Submit all Product Data as a single combined package. Partial submittals; SD-02, SD-03, and SD-05 submittals not submitted simultaneously; SD-02, SD-03, and SD-05 submittals submitted prior to SD-01 submittals approval; and submittals not fully complying with the requirements of applicable NFPA standards and this specification; are not acceptable.

1.4.1 Submittal Schedule

Submit all Preconstruction Submittals (SD-01) within [14][_____] days following Notice to Proceed and before any other classification of submittal. Provide submittals for SD-02, SD-03,[SD-04,] and SD-05 no less than [21][_____] days prior to the proposed start of construction on the subject system. Provide other submittals as specified in other paragraphs of this specification.

1.4.2 Shop Drawings

Provide job specific shop drawings reflecting the actual proposed installation conditions for this project. Do not submit the manufacturer's generic system layout plans, details, and diagrams. Provide drawings that are compliant with the Plans section of NFPA 12 and the following. Submit plan views showing system layout, including nozzles, piping, hangers, [seismic separation assemblies, seismic zones of influence, sway bracing,]and carbon-dioxide storage tank(s) or cylinders. Ensure drawings reflect the actual proposed pipe routing as it will be installed in the field. Clearly indicate the location, size, orientation, and type of all valves, pipe size reductions, and pipe fittings. Show an isometric view of the fire-extinguishing system. Show details of each type of hanger[,][and] pipe support[,][and seismic brace] to be provided.

1.4.3 Product Data

****
NOTE: Include the bracketed text when specifying an electric releasing system.
****

Provide manufacturer's product data sheets for each system component to be provided, including at least each item specified herein. Annotate product

data sheets to indicate precise equipment that is to be provided, including an indication of all options selected. Submit copies of current listings or approvals for all equipment furnished. Submit listing or approval documentation from a nationally recognized testing laboratory (NRTL) for each piece of equipment showing that such equipment is listed or approved for use in fire protection systems.[Submit listing or approval documentation from a NRTL showing that the proposed releasing solenoid is compatible with the proposed releasing system fire alarm control unit (RSFACU).]

1.4.4 Design Data

1.4.4.1 Supply Calculations

Submit carbon-dioxide supply calculations to substantiate that the provided carbon-dioxide storage capacity is adequate to protect the anticipated hazard(s). Ensure calculations consider residual carbon-dioxide that will be left in the supply piping, capacity for uncloseable openings, and sufficient redundant capacity as required herein.

1.4.4.2 Pipe and Orifice Size Calculations

Submit pipe and orifice size calculations to substantiate that the carbon-dioxide fire-extinguishing system piping and discharge orifices are sized appropriately to protect the anticipated hazard within the required period of time.[Use system manufacturer provided sizing software or provide manufacturer supplied calculations.]

1.4.4.3 Seismic Bracing Design

****
NOTE: Coordinate with the geotechnical and structural engineers to establish the seismic design category and Ss value to include in this specification.
****

[Prepare seismic bracing calculations and details as described in NFPA 13. The seismic design information applicable to this project includes: design category ["_____"], Ss=[_____g].][The seismic design category applicable to this project is design category ["_____"], and seismic bracing is not required.]

1.4.5 Test Reports

Submit reports for inspections and tests specified under paragraphs titled "FIELD QUALITY CONTROL". Submit test reports in booklet form showing field tests performed to prove compliance with the specified performance criteria upon completion and testing of the installed system. Document readings, test results, and the final position of controls on each test report.

1.4.6 Operation and Maintenance Instructions

****
NOTE: Edit brackets based on whether hard copy manuals (first bracketed options) or electronic only manuals (second bracketed options) will be provided.
****

Submit the Operation and Maintenance Instructions indexed and in booklet form as a single[volume][file] or in separate[volumes][files]. Inscribe the following identification on the[cover][cover sheet]: the words "CARBON-DIOXIDE FIRE-EXTINGUISHING SYSTEM OPERATION AND MAINTENANCE MANUAL", the name of the building, the number of the building, the name of the Installer, the name of the system manufacturer, and the Contract number. Provide instructions that are legible and easily read, with full size drawings[folded in][included].

Provide submittals for SD-10 at least [21][_____] days prior to the proposed start of training. Do not provide training prior to approval of SD-10 submittals. Include at least the following in the Operation and Maintenance Instructions:

a. "Data Package Five" as specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA.

b. Routine maintenance checklist arranged in a columnar format. List all installed components in the first column, state the maintenance activity or state no maintenance required in the second column, state the frequency of the maintenance activity in the third column, and provide a fourth column for additional comments or reference.

1.4.7 As-Built Drawings

Show the system as installed, including deviations from both the Contract Drawings and the approved shop drawings. Ensure the accuracy of the as-built drawings is plus or minus 150 millimeters (mm) 6 inches for all discharge orifices and equipment locations, and plus or minus 300 mm 12 inches for all piping. Maintain redlined as-built mark-ups throughout the duration of construction and incorporate these mark-ups into the native drawing files for the final As-Built Drawings Submittal.

Prepare the drawings in the same format, size, and layout as the approved shop drawings.

1.5 SPECIAL TOOLS AND SPARE PARTS

Furnish special tools necessary for the maintenance of the equipment. Submit spare parts data for each different item of material and equipment specified, after approval of shop drawings, and not later than [60][_____] days prior to the anticipated date of beneficial occupancy. Include a complete list of parts and supplies with the current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after [one][_____] year[s] of service.

Furnish the following spare parts:

****
NOTE: Edit this list as desired by the contracting organization. Generally, spare parts are discouraged by UFC 1-300-02: UNIFIED FACILITIES GUIDE SPECIFICATIONS (UFGS) FORMAT STANDARD, but some hard to replace or easily lost items may be warranted for inclusion.
****

a. [_____]

b. [_____]

1.6 QUALITY ASSURANCE

1.6.1 Materials

Provide all labor, material, tools, and equipment necessary for and incidental to a complete and usable carbon-dioxide fire-extinguishing system.

****

NOTE: For OCONUS projects, use the blank brackets to insert local certification organizations that are considered equivalent to United States (U.S.) Nationally Recognized Testing Laboratories (NRTLs) for your project.

****

Ensure all devices, appliances, and equipment for fire protection service are listed or approved by [UL Fire Prot Dir, FM APP GUIDE, or another NRTL acceptable to the Government's Designated (or Service) Fire Protection Engineer (DFPE)][_____] for the intended use. For components that must function together to form a system, ensure they are listed or approved by the same NRTL.

1.6.2 Codes, Standards, and Manufacturer's Literature

Provide the system in accordance with NFPA 12, NFPA 70, NFPA 72, NFPA 90A, and as specified herein. Interpret reference to "authority having jurisdiction" to mean the Contracting Officer.

Follow all recommended installation and start-up practices stated in the manufacturer's literature or documentation.

1.6.3 Qualifications

****

NOTE: Section 01 45 00 QUALITY CONTROL includes requirements related to the Fire Protection Quality Control Specialist (FPQC). Edit that Section as necessary to refine the requirements for the FPQC to the project. Coordinate with the DFPE to ensure edits meet their expectations. The intent is for the FPQC defined in the 01 45 00 QUALITY CONTROL Section to provide the review and oversight required by UFC 3-600-01: FIRE PROTECTION ENGINEERING FOR FACILITIES. Only include the requirements related to that FPQC in the 01 45 00 QUALITY CONTROL Section; do not include them in this Section. The tailoring applied to all mentions of a Qualified Fire Protection Engineer (QFPE) in this Section is intentional. A QFPE, as discussed in this Section, is only required for Army projects and is in addition to the FPQC required by the 01 45 00 QUALITY CONTROL Section. The QFPE specified in this Section for Army projects is not permitted to also fulfill the role of FPQC as specified in the 01 45 00 QUALITY CONTROL Section.

****

1.6.3.1 Qualified Fire Protection Engineer (QFPE)

Provide the services of a Qualified Fire Protection Engineer (QFPE). A QFPE is an individual who is a licensed Professional Engineer (P.E.), who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveying (NCEES) and has relevant fire protection engineering experience. Ensure that the QFPE is an integral part of the construction team and is involved in every aspect of the system's submittals, installation, and testing. Ensure that the QFPE does not also serve as the Fire Protection Quality Control Specialist (FPQC) as defined by Section 01 45 00 QUALITY CONTROL. Submit the Qualified Fire Protection Engineer's Qualifications, including the name and documentation of qualifications of the proposed QFPE.

Ensure the QFPE:

****

NOTE: UFC 3-600-01: FIRE PROTECTION ENGINEERING FOR FACILITIES requires that shop drawings, calculations, and material data sheets bear the Professional Engineer seal and signature of the QFPE prior to submission to the FPQC for approval.

****

a. Prepares, or directly supervises preparation of, construction (shop) drawings and calculations.

b. Reviews all required shop drawings, material data, calculations, qualifications, test procedures, test reports, as-built drawings, and O&M manuals for completeness and compliance with the provisions of this Contract prior to submitting them to the FPQC.

c. Affixes his or her Professional Engineer seal with signature to the shop drawings, calculations, and material data sheets, indicating approval prior to submitting them to the FPQC.

d. Performs in-progress construction surveillance prior to installation of ceilings (rough-in inspection)[or closure of trenches]. Performs at least [one][_____] interim site observation visit[s] prior to completion of installation, separate from the preliminary testing, to confirm that all systems are being installed in accordance with the Contract.

e. Witnesses and approves all preliminary and final functional performance testing and performs a final installation review.

f. Signs applicable certificates under SD-07.

1.6.3.2 Installer

Provide an Installer that is regularly engaged in the installation of the type and complexity of system specified herein. Submit the Installer's Qualifications including written certificate demonstrating that the carbon-dioxide fire-extinguishing system Installer has been regularly engaged in the installation of such systems meeting NFPA standards for a minimum of three years immediately preceding commencement of this

Contract. Include proof of satisfactory performance on at least three projects similar to that required by these specifications, including the names and telephone numbers of using agency points of contact for each of these projects. Indicate the type of each system installed and include a written certification that each system has performed satisfactorily in the manner specified for a period of not less than 18 months following completion. Ensure Installer is able to provide service within 24 hours.

1.6.3.3 Supervisor

Provide the services of a qualified technician, factory trained, certified, and experienced in the installation and operation of the type of system being provided to supervise the installation, adjustment, preliminary testing and final testing of the system, and to provide instruction to Government operating and maintenance personnel.

Submit the Supervisor's Qualifications including name(s) of the Supervisor(s) who will oversee installation and testing of the system, and who will provide instruction to Government personnel, along with the manufacturer's certification of the qualifications of the proposed Supervisor(s).

1.6.3.4 Designer

****
NOTE: Tailoring options are included in this paragraph to differentiate between the duties of the Designer under Army projects versus Non-Army projects.
****
****
NOTE: UFC 3-600-01: FIRE PROTECTION ENGINEERING FOR FACILITIES specifically requires that the Designer be certified by the National Institute for Certification in Engineering Technology (NICET). In order for a Designer holding a certification from another entity to be considered acceptable, they must request an equivalency be approved by the Component Fire Protection Engineer (CFPE).
****

Prepare shop drawings, product data, design data, O&M manual(s), and as-built drawings by, or under the direct supervision of, the Designer. Ensure that the Designer is an individual who is experienced with the types of work specified herein and is currently certified by the National Institute for Certification in Engineering Technologies (NICET) as an engineering technician with Level IV certification in Special Hazards Systems. Submit the Designer's Qualifications including the name and documentation of certification of the proposed Designer.

Ensure that the Designer:

a. Reviews all required shop drawings, material data, calculations, qualifications, test procedures, test reports, as-built drawings, and O&M manuals for completeness and compliance with the provisions of the Contract prior to submitting them to the FPQC.

b. Performs in-progress construction surveillance prior to installation of ceilings (rough-in inspection)[or closure of trenches]. Performs

at least [one][_____] interim site observation visit[s] prior to completion of installation, separate from the preliminary testing, to confirm that all systems are being installed in accordance with the Contract.

c. Witnesses and approves all preliminary and final functional performance testing and performs a final installation review.

d. Signs applicable certificates under SD-07.

[1.7 EXISTING CONDITIONS

****
NOTE: Include this paragraph if adding onto or modifying an existing system.
****

Provide new equipment that is compatible with the existing system, manufactured by [_____]. Ensure that new equipment does not negatively impact existing system operations or reliability.

]PART 2 PRODUCTS

2.1 DESIGN CRITERIA

****
NOTE: Ensure that no suffocation hazard will exist in any rooms with underfloor total flooding systems or within any space to which the carbon-dioxide might migrate after discharge. Consult with the DFPE if in doubt.
****
****
NOTE: It is critically important that the design engineer take into account the potential pressure changes within the protected space upon carbon-dioxide release. Coordinate with the architect, structural engineer, and mechanical engineer to ensure that proper venting is provided to avoid overpressurization of the protected space.
****

Design the system in accordance with NFPA 12, except as modified herein.

****
NOTE: Include applicable paragraphs based on the type of system being provided.
****

[2.1.1 Underfloor Total Flooding Systems

****
NOTE: If there is more than one underfloor area (separated from other underfloor areas by essentially gas-tight partitions) which require protection, list them as separate areas and delineate each area by reference to room numbers, space designations, or zones. Show such zones on the Contract Drawings.

****
****

NOTE: Calculate the flooding factor and design concentration in accordance with NFPA 12. Whenever possible, provide for automatic closing of openings and shutting down of ventilation systems prior to start of gas discharge. When this cannot be done, identify the size of openings and capacity of ventilation systems and adjust the gas quantity accordingly.

****

Provide uniform discharge to each protected space to achieve a flooding factor of [_____] grams (g) [_____] pounds of carbon-dioxide for each cubic meter cubic foot of protected volume in one minute, in order to produce a minimum design carbon-dioxide concentration of [50][34][_____] percent. Provide a minimum supply of carbon-dioxide of [_____] grams [_____] pounds.[Provide additional carbon-dioxide discharge as required by NFPA 12 to compensate for[[_____] square centimeterssquare feet of openings that cannot be closed][,][and][[_____] cubic centimeters per minutecubic feet per minute of ventilating systems that cannot be shut down][,][and][[high][low] ambient temperatures of [_____] degrees Celsius (C) Fahrenheit (F)].] Ensure the protected space, carbon-dioxide system(s), and supply of carbon-dioxide are configured to maintain the required carbon-dioxide design concentration for the minimum hold time of [10][20][_____] minutes.

Supply each protected space with carbon-dioxide through a selector valve from the storage tank(s) or cylinders, so that activation of the system in one space does not cause discharge of carbon-dioxide into another space.

][2.1.2 Room Total Flooding Systems

****

NOTE: Calculate the flooding factor and design concentration in accordance with NFPA 12. Whenever possible, provide for automatic closing of openings and shutting down of ventilation systems prior to start of gas discharge. When this cannot be done, identify the size of openings and capacity of ventilation systems and adjust the gas quantity accordingly.

****

Provide uniform discharge to each protected space to achieve a flooding factor of [_____] grams [_____] pounds of carbon-dioxide for each cubic meter cubic foot of protected volume in one minute, in order to produce a minimum design carbon-dioxide concentration of [34][_____] percent. Provide a minimum supply of carbon-dioxide of [_____] grams [_____] pounds.[Provide additional carbon-dioxide discharge as required by NFPA 12 to compensate for[[_____] square centimeterssquare feet of openings that cannot be closed][,][and][[_____] cubic centimeters per minutecubic feet per minute of ventilating systems that cannot be shut down][,][and][[high][low] ambient temperatures of [_____] degrees C F].] Ensure the protected space, carbon-dioxide system(s), and supply of carbon-dioxide are configured to maintain the required carbon-dioxide design concentration for the minimum hold time of [10][20][_____] minutes.

][2.1.3 Local Application Systems

****
NOTE: Use this paragraph for dip tanks, quench tanks, and similar hazards that cannot be totally flooded because they are not enclosable. Follow NFPA 12 for design requirements.
****

Provide local application of carbon-dioxide for the protection of [_____]. Calculate the quantity of carbon-dioxide required for local application in accordance with NFPA 12. Base calculations on the total rate of discharge needed to blanket the[area][or][volume] protected, and the time that discharge must be maintained to ensure complete extinguishment. Ensure the minimum discharge time is[30 seconds][[_____] minute[s]]. Base calculations on the[rate-by-area method for flat surfaces][and][rate-by-volume method for three-dimensional hazards].

]2.2 CARBON-DIOXIDE SUPPLY

****
NOTE: Calculate the anticipated size of tank(s) or number of cylinders to determine the area required for installation and coordinate required clearances and structural support with other disciplines.
****
****
NOTE: Edit the specification to include the requirement to provide 100 percent reserve supply unless otherwise directed by the DFPE.
****
****
NOTE: Odorizer is an optional component that should be considered for use especially when personnel may be exposed to leaking or migrating carbon-dioxide.
****
****
NOTE: Tailoring options have been used in this paragraph to differentiate requirements between low-pressure and high-pressure systems.
****

Provide a low-pressure (2068 kilopascal (kPa)300 pounds per square inch (psi)), refrigerated, carbon-dioxide storage tank, complete with a full charge of carbon-dioxide, a liquid level indicator, and other necessary components and appurtenances.[Provide liquid level gauge capable of being monitored by the RSFACU to indicate a low carbon-dioxide supply condition.] Calculate the size of tank to include sufficient carbon-dioxide for the hazard requiring the largest volume of carbon-dioxide[plus 100 percent reserve supply]. In the event this calculated amount falls between available sizes of tanks, provide the next largest tank. Provide carbon-dioxide supply calculations to validate the size of tank selected. Supply[all][underfloor total flooding][,][and][room total flooding][,][and][local application] systems from this tank. Provide high-pressure carbon-dioxide storage cylinders complete with a full charge of carbon-dioxide, racks, manifolds, beam scales, and necessary components and appurtenances. Provide [34][45][23][_____] kilogram (kg)[75][100][50][_____] pound cylinders. Calculate the quantity of cylinders to include sufficient carbon-dioxide for the hazard requiring the largest volume of carbon-dioxide[plus 100 percent reserve supply].

In the event this calculated amount results in a partial cylinder, round the quantity of cylinders required up to the next highest whole number. Provide carbon-dioxide supply calculations to validate the number of cylinders selected. Supply[all][underfloor total flooding][,][and][room total flooding][,][and][local application] systems from these cylinders. Arrange cylinders to differentiate between primary and reserve cylinder banks.

[2.2.1 Odorizer

Provide a pressure actuated wintergreen odorizer assembly on each system.

]2.3 PIPE AND FITTINGS

2.3.1 Layout

Do not locate carbon-dioxide piping in any area where a pipe break or leak could make a normally occupied area untenable. Provide pipe and orifice sizing calculations to validate the system design.

2.3.2 Pipe

****
NOTE: If the system is being installed in a highly corrosive atmosphere, consider specifying the use of stainless steel piping in lieu of black or galvanized steel as described below. Consult with the DFPE regarding the appropriateness of specifying stainless steel due to the significantly higher cost of materials.
****
****
NOTE: Tailoring options have been used in this paragraph to differentiate requirements between low-pressure and high-pressure systems.
****

Provide[ASTM A53/A53M, Type E or Type S, Grade A or Grade B,][or][ASTM A106/A106M, Grade A, Grade B, or Grade C,][black][or][galvanized] steel pipe. Ensure pipe nipples 150 mm 6 inches long and shorter are Schedule 80 or stronger steel pipe.

Comply with the manufacturer's written installation instructions or the following, whichever is more stringent. For piping under continuous pressure, provide Schedule 80 or stronger pipe. For piping not under continuous pressure, provide Schedule 40 or stronger pipe.Comply with the manufacturer's written installation instructions or the following, whichever is more stringent. Provide Schedule 40 or stronger pipe for sizes 20 mm 0.75 inch and smaller. Provide Schedule 80 or stronger pipe for sizes 25 mm one inch through 100 mm 4 inch. Calculate the required minimum pipe strength in accordance with ASME B31.1 for all other sizes of pipe.

2.3.3 Fittings

Provide fittings of the type and class required by NFPA 12. Provide tapered-reducing pipe fittings for changes in piping size; do not use bushings.

2.3.4 Lockout Valves

Provide each zone with a manually operated lockout valve that includes positive visual indication of valve position.[Equip each lockout valve with a status switch capable of reporting the valve's position to the RSFACU.]

2.3.5 Discharge Orifices

Provide discharge orifices in accordance with NFPA 12.

2.4 PIPING ACCESSORIES

2.4.1 Escutcheon Plates

Provide one piece or split hinge type metal plates for piping passing through floors, walls, and ceilings in exposed spaces. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces. Provide paint finish on metal plates in unfinished spaces. Securely anchor plates in place with setscrews or other approved positive means.

2.4.2 Pipe Sleeves

Provide pipe sleeves where piping passes entirely through walls, ceilings, roofs, and floors. Provide sleeves of sufficient length to pass through the entire thickness of walls, ceilings, roofs, and floors.

a. Sleeves in Masonry and Concrete: Provide hot-dipped galvanized steel, ductile-iron, or cast iron sleeves at walls, ceilings, roofs, and floors. Core-drilling of masonry and concrete may be provided in lieu of sleeves as long as cavities in the core-drilled holes are completely grouted smooth.

b. Sleeves in Other Than Masonry and Concrete: Provide 551 micrometer (µm) 26 gage galvanized steel sheets.

Secure sleeves in proper position and location. Provide 25 mm one inch minimum clearance between exterior of piping and interior of sleeve or core-drilled hole. Firmly pack annular space with mineral wool insulation and seal both ends of sleeve or core-drilled hole with plastic waterproof cement which will dry to a firm but pliable mass, or provide mechanically adjustable segmented elastomeric seal. Protect penetrations of fire resistance rated construction with listed firestopping assemblies.

2.4.3 Pipe Hangers and Supports

****
NOTE: Specify MSS SP-58 for projects where seismic qualification is not required. Specify MSS SP-127 for projects where seismic qualification is required.
****

Provide[MSS SP-58][MSS SP-127] compliant, Type 1 pipe hangers and supports, with adjustable type steel support rods, except as modified herein or indicated otherwise on the Contract Drawings. Attach to steel joists with Type[19][or][23] clamps and retaining straps. Attach to steel W or S beams with Type[21][,][or][28][,][or][29][,][or][30] clamps. Attach to steel angles and vertical web steel channels with Type

20 clamps with beam clamp channel adapter. Attach to horizontal web steel channel and wood with drilled hole on centerline and double nut and washer. Attach to concrete with Type 18 insert or drilled expansion anchor.[Provide seismic bracing calculations to validate seismic bracing designs.]

2.4.4 Pressure Relief Device

****
NOTE: Tailoring options have been used in this paragraph to differentiate requirements between low-pressure and high-pressure systems.
****

Provide each section of closed piping with a pressure relief device designed to operate at 3102 kPa 450 psi.Provide each section of closed piping with a pressure relief device designed to operate at no less than 16500 kPa 2,400 psi and no more than 20700 kPa 3,000 psi.

2.5 SYSTEM CONTROL

****
NOTE: The Fire Protection Engineering Design Working Group (FPE DWG) has evaluated the impact of inserting almost all of the requirements from Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE into this Section in order to keep the releasing service fire alarm system requirements included in the same section as the rest of the carbon-dioxide fire-extinguishing system requirements. They determined that this approach is undesirable, and have provided direction to use Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE as the base specification for the releasing service fire alarm system associated with the carbon-dioxide fire-extinguishing system. Eventually, the FPE DWG intends to develop a dedicated specification section for releasing service fire alarm systems. Until such a section is created, edit Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE to cover the releasing service fire alarm system requirements associated with this project (if applicable).
****
****
NOTE: Tailoring options have been used in this paragraph to differentiate requirements between low-pressure and high-pressure systems.
****

Provide apparatus, accessories, components, and associated materials specified or required. Provide[an][a][automatic][and][manual][combination][electric][and][pneumatic][and][mechanical] type actuating control system complete and ready for operation.[For electrically actuated systems, provide complete "Class B" electrical supervision. Achieve automatic actuation by[smoke][and][or][heat] detectors.][For electrically actuated systems, provide main and reserve switch. Configure switch to select between main and reserve carbon-dioxide supplies, located adjacent to the cylinder bank or at the

control panel. Provide complete "Class B" electrical supervision. Achieve automatic actuation by[smoke][and][or][heat] detectors.][

Provide the releasing service fire alarm system in accordance with Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE, as supplemented by this Section.]

2.5.1 Manual Release Stations

****

NOTE: Locate stations at or near exits from the protected areas. Provide separate stations for each hazard.

****

Provide manual release stations for[underfloor total flooding][,][and][room total flooding][,][and][local application] systems. Provide dual action manual release stations that do not incorporate break-glass elements. Ensure manual release stations include language clearly indicating the intended use and are clearly distinguishable as different from fire alarm system manual pull stations in the building.

2.5.2 Sequence of Operation

****

NOTE: If system is electrically actuated, include the sequence of operations requirements within Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE, and select the first bracketed text in this paragraph unless specifically directed otherwise by the DFPE. If the system is pneumatically or mechanically actuated, select the second bracketed text in this paragraph.

****

****

NOTE: Generally, a discharge time of one minute is appropriate for underfloor and room total flooding applications. A discharge time of 30 seconds may be appropriate for a local application system. Edit the discharge duration to match the hazard being protected.

****

2.5.2.1 General

[Refer to Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE, for sequence of operations.][Configure the system such that upon activation of a manual release station, the system immediately activates discharge notification appliances in the protected areas; signals the building fire alarm control unit to activate the building fire evacuation alarms; sends a signal to the supervising station[via the building fire alarm control unit's connection to the Installation fire alarm reporting system]; shuts down[computer][,][and][air handling][,][and][_____] equipment; closes dampers[,][and][doors][,][and][windows]; and initiates an adjustable zero to 60 second discharge time delay. Configure the system such that upon expiration of the discharge time delay, carbon-dioxide flows from the storage tank(s) or cylinders, through the selector valve associated with the zone protected by the activated manual release station, and discharges into the protected space for a period of[one minute][30 seconds][

[_____] minute(s)], and activates the post-discharge notification appliances.

[Configure the system such that upon activation of the emergency manual discharge lever on the tank or cylinder the system immediately activates post-discharge notification appliances in the protected areas; signals the building fire alarm control unit to activate the building fire evacuation alarms; sends a signal to the supervising station[via the building fire alarm control unit's connection to the Installation fire alarm reporting system]; shuts down[computer][,][and][air handling][,][and][_____] equipment; closes dampers[,][and][doors][,][and][windows]; and initiates carbon-dioxide discharge into the protected area.]

][2.5.2.2 Pressure-Switch Operation

****
NOTE: Only include this paragraph if the system is pneumatically or mechanically actuated and equipped with a discharge pressure switch.
****

Provide a pressure-switch to initiate the following functions upon discharge of carbon-dioxide if not already initiated: activate post-discharge notification appliances in the protected areas; signal the building fire alarm control unit to activate the building fire evacuation alarms; send a signal to the supervising station[via the building fire alarm control unit's connection to the Installation fire alarm reporting system]; shut down[computer][,][and][air handling][,][and][_____] equipment; and close dampers[,][and][doors][,][and][windows].

][2.5.3 Inhibit Switches

****
NOTE: Include this paragraph only when electrical actuation is specified.
****

Provide one switch per zone. Arrange the switch such that activation physically disables carbon-dioxide release by breaking the releasing circuit. Ensure that the switch requires a key to operate, and supervise with the RSFACU such that operation of the switch causes a supervisory signal to be transmitted to the supervising station[via the building fire alarm control unit's connection to the Installation fire alarm reporting system].

][2.5.4 Discharge Pressure Switches

****
NOTE: Include this paragraph only when a discharge pressure switch is to be provided. If the carbon-dioxide fire-extinguishing system is electrically actuated, monitor the discharge pressure switch with the RSFACU. If the carbon-dioxide fire-extinguishing system is pneumatically or mechanically actuated, monitor the discharge pressure switch with the building's fire alarm control unit.
****

Provide each system with a discharge pressure switch monitored by the[RSFACU][building's fire alarm control unit]. Ensure that the pressure switch supervises the pressure in the piping downstream of the releasing solenoid such that it is activated when gas is discharged. Provide switch with two sets of single-pole double-throw (SPDT) form-C contacts capable of connection to 24 VDC and [100-120][200-240] VAC outputs. Ensure the switch has screw terminal connections and is capable of being wired for a normally open or normally closed circuit.

]2.5.5 Alarm Notification Appliances

****
NOTE: If the carbon-dioxide fire-extinguishing system is electrically actuated, power and supervise the notification appliances from the releasing service fire alarm system. If the carbon-dioxide fire-extinguishing system is pneumatically or mechanically actuated, power and supervise the notification appliances from the building's fire alarm system.
****

Provide each protected area with audible and visual alarms located[to provide public mode notification in accordance with NFPA 72][as shown on the Contract Drawings]. Electrically supervise all alarm circuits with the[RSFACU][building's fire alarm control unit]. Power notification appliances from the[releasing service fire alarm system][building's fire alarm system]. Provide separate and distinct audible and visual pre-discharge, discharge, and post-discharge signals. Where the building is equipped with a separate fire evacuation alarm system, ensure that the discharge signals are also distinct from those used by the building fire evacuation system. Provide each notification appliance with a rigid plastic or metal identification sign with lettering a minimum of 40 mm 1.5 inches high. Label the pre-discharge alarms with the word "FIRE". Label the discharge alarms with the words "CARBON-DIOXIDE DISCHARGE". Locate the post-discharge alarms outside entrances to protected areas and provide them with warning signs reading "CARBON-DIOXIDE DISCHARGED WHEN FLASHING - DO NOT ENTER".

2.5.5.1 Alarm Horns

****
NOTE: Select the horn output patterns included below unless they conflict with the building's fire evacuation system horn pattern. If they conflict with the building's fire evacuation horn pattern, consult with the DFPE to determine the appropriate horn patterns to specify.
****

Provide[surface mounted,][recessed,] 24 VDC, red, vibrating type, alarm horns suitable for use in an electrically supervised circuit that produce a sound output of at least 90 decibels at 3 meters 10 feet. Configure pre-discharge horns to produce a march-time horn pattern, and configure discharge and post-discharge horns to produce a high-low horn pattern.

2.5.5.2 Visual Alarms

Provide[surface][flush] mounted, 24 VDC, visual alarms suitable for use

in an electrically supervised circuit. Ensure visual alarm appliances are the flashing stroboscopic type. Select strobe candela rating in accordance with NFPA 72 criteria for the given space, taking into consideration any de-rating required for the colored lens. Ensure flash rate is between 60 and 120 flashes per minute. Provide visual alarm appliances with a colored thermoplastic lens, red for pre-discharge alarms and blue for discharge and post-discharge alarms. Visual alarms may be part of an audio-visual alarm assembly. Where more than two stroboscopic type appliances are located in the same field of view, provide synchronized operation.

[2.6 AUTOMATIC FIRE-SMOKE DAMPERS

****
NOTE: It is imperative that close coordination occur between the fire protection engineer and the mechanical engineer to ensure that requirements for dampers are coordinated between disciplines and specification sections are aligned.
****
****
NOTE: Ensure that the mechanical design for the project includes a detail of the fire-smoke dampers, addresses heating, ventilation, and air conditioning unit shut down (if applicable), and clearly differentiates between the locations of fire dampers and of fire-smoke dampers controlled as a part of the fire-extinguishing system sequence of operations on the Contract Drawings.
****
****
NOTE: If the carbon-dioxide fire-extinguishing system is electrically actuated, power, control, and monitor the dampers from the releasing service fire alarm system. If the carbon-dioxide fire-extinguishing system is pneumatically or mechanically actuated, power, control, and monitor the dampers from the building's fire alarm system.
****

Provide automatic control of fire-smoke dampers in openings and ductwork penetrating the envelope of the protected area. Dampers are specified in Section [23 30 00 HVAC AIR DISTRIBUTION][_____], as supplemented below. Ensure that dampers close in sequence as specified in the paragraph entitled "Sequence of Operation".

2.6.1 Power

Provide automatic fire-smoke dampers that operate on 24 VDC. Power each automatic fire-smoke damper with the[RSFACU][building's fire alarm control unit].

2.6.2 Control

Control each automatic fire-smoke damper with the[RSFACU][building's fire alarm control unit]. Do not rely on the heating, ventilation, and air conditioning system controls system to control these dampers in a fire event.

2.6.3 Monitoring

Monitor the position of each automatic fire-smoke damper with the[RSFACU][building's fire alarm control unit]. Provide each damper with two sets of factory installed SPDT (Form C) switches for use in monitoring the position of the damper. Ensure one set of switches changes state to indicate when the damper is fully open and the other set of switches changes state to indicate when the damper is fully closed.

2.6.4 Fail-Safe

Ensure automatic fire-smoke dampers are configured to close upon loss of power.

][2.7 SMOKE AND CARBON-DIOXIDE EXHAUST SYSTEM

****

NOTE: It is imperative that close coordination occur between the fire protection engineer and the mechanical engineer to ensure that requirements for the smoke and carbon-dioxide exhaust system are coordinated between disciplines and specification sections are aligned.

****

Provide under Section [23 30 00 HVAC AIR DISTRIBUTION][_____] and as specified herein. Provide a key-operated ON-OFF switch with red and green indicator lights for control of exhaust fans from each protected space. Ensure the green light remains illuminated when the exhaust system is in standby status. Ensure that green light extinguishes and red light illuminates when the system is operating. Provide an interlock from the carbon-dioxide system to prevent operation of the exhaust system during carbon-dioxide system discharge and for a minimum of [10][20][_____] minutes after carbon-dioxide discharge. Configure the system such that the exhaust system is operable by key switch [10][20][_____] minutes after carbon-dioxide discharge, even if smoke detectors are still in alarm mode. Locate switch(es) outside of the protected space(s).

]2.8 OPERATING INSTRUCTIONS

Provide operating instructions at each manual release station and at the emergency manual actuation lever. Ensure that the instructions clearly indicate the steps for system operation. Submit a graphical representation of the proposed operating instructions as a part of the shop drawings or product data submittals. Provide instructions that incorporate raised or embossed white letters on red rigid plastic or enameled steel backgrounds. Ensure that lettering is a minimum of 6 mm 0.25 inch high.

2.9 SIGNS

Provide signs in accordance with NFPA 12.

PART 3 EXECUTION

3.1 VERIFICATION OF CONDITIONS

Become familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of discrepancies before performing the

work.

[3.2 CONTINUITY OF PROTECTION

During installation of the system, ensure there is no loss of function of the existing building carbon-dioxide fire-extinguishing system. Temporary interruption in operability of the existing system, not to exceed eight hours in duration, may be permitted at the discretion of the Contracting Officer.

]3.3 INSTALLATION

Provide equipment, materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing in accordance with NFPA 12, NFPA 70, NFPA 72, and NFPA 90A, except as modified herein. Install piping straight and true to bear evenly on hangers and supports. Keep the interior and ends of new piping[and existing piping affected by the Contractor's operations] thoroughly cleaned of water and foreign matter. Keep piping systems clean during installation by means of plugs or other approved methods. When work is not in progress, securely close open ends of piping to prevent entry of water and foreign matter. Inspect piping before placing into position.

3.3.1 Electrical

****

NOTE: Include the first bracketed text if the carbon-dioxide fire-extinguishing system is electrically actuated. Include the second bracketed text if the carbon-dioxide fire-extinguishing system is pneumatically or mechanically actuated.

****

Provide electrical work associated with this Section in accordance with NFPA 70 and as specified under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM[and Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE].[Provide electrical work associated with connections to the building's fire alarm system under Section[28 31 60 INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE][28 31 66 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE][28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE][28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE].] Provide wiring in rigid metal conduit or intermediate metal conduit, except electrical metallic tubing may be provided in dry locations not enclosed in concrete and where not subject to mechanical damage.

3.3.2 Manual Release Stations

Provide manual release stations [at the principal exits from each protected space][and][where shown on the Contract Drawings][_____]. For systems that are mechanically or pneumatically activated, provide a separate station for main supply and for reserve supply of carbon-dioxide at each location. For electrically activated systems, provide one station at each location. Mark each station to indicate its function.

3.3.3 Pipe and Fittings

Test, inspect, and approve piping before concealing. Provide fittings for direction changes in piping and for connections. Provide

polytetrafluoroethylene (PTFE) pipe thread tape, pipe cement and oil, or PTFE powder and oil for pipe jointing compound; apply only to male threads. Provide exposed ferrous pipe threads with one coat of zinc molybdate primer applied to a minimum dry film thickness of 25 µm one mil.

3.3.4 Pipe Hangers and Supports

Provide additional supports for the concentrated loads in piping between hangers and supports, such as for valves. Support steel piping as follows:

Nominal Pipe Size (mm)	25 and Under	32	40	50	65	80	100	125	150
Maximum Spacing (mm)	2100	2400	2750	3000	3400	3700	4300	4600	5200

Nominal Pipe Size (inches)	1.0 and Under	1.25	1.5	2	2.5	3	4	5	6
Maximum Spacing (feet)	7	8	9	10	11	12	14	15	17

3.4 FIELD PAINTING

****
NOTE: Coordinate Section 09 90 00 PAINTS AND COATINGS with this paragraph.
****

Clean, pretreat, prime, and paint new carbon-dioxide fire-extinguishing systems including valves, piping, conduit, hangers, supports, miscellaneous metalwork, and accessories. Apply coatings to clean, dry surfaces, using clean brushes. Clean surfaces to remove dust, dirt, rust, and loose mill scale. Immediately after cleaning, provide the metal surfaces with one coat of zinc molybdate primer applied to a minimum dry film thickness of 25 µm one mil. Shield operating devices with protective covering while painting is in process. Upon completion of painting, remove protective covering from operating devices. Remove devices which are painted and replace with new devices. Provide primed surfaces with the following:

3.4.1 Systems in Unfinished Areas

Unfinished areas are defined as attic spaces, spaces above suspended ceilings, crawl spaces, pipe chases, and spaces where walls or ceilings are not painted nor constructed of a prefinished material. Provide primed surfaces with one coat of red alkyd gloss enamel applied to a minimum dry film thickness of 25 µm one mil.

3.4.2 Systems in Other Areas

Provide primed surfaces with two coats of paint to match adjacent

surfaces, except provide valves and operating accessories with one coat of red alkyd gloss enamel applied to a minimum dry film thickness of 25 µm one mil. Provide piping with 50 mm 2 inch wide red enamel bands or self-adhering red plastic tape bands spaced at a maximum of 6 meter 20 foot intervals throughout the piping systems with at least one band in each space.

3.5 CORROSION AND FUNGUS PREVENTION

Coat outdoor equipment with a rust inhibiting treatment and standard finish by the manufacturer. Do not use aluminum in contact with the earth. Protect dissimilar metals with approved fittings and treatment. Coat steel conduits installed underground with an approved asphaltic paint or plastic coating, or wrap with a single layer of a pressure sensitive plastic tape, half-lapped. Protect components against corrosion and fungus.

3.6 FIELD QUALITY CONTROL

Ensure installed piping is tested, inspected, and approved before covering or concealing.

Perform integrated systems testing in accordance with NFPA 4.

3.6.1 Interim Construction Observation Visit[s]

Perform interim construction observation visit[s] when construction is[sufficiently underway to provide sufficient evidence of installation practices being followed, but not so far along as to cause major schedule delays to correct any deficiencies observed][approximately[25 percent][,][50 percent][,][and][75 percent] complete]. Document each site observation visit with a separate site observation report documenting what was observed and any corrective actions required as a result of the visit. Submit site observation report(s) within [14][_____] days of conclusion of respective site observation visit.

3.6.2 Test Procedures

Submit detailed test procedures at least [30][_____] days prior to proposed start of performing system tests. List all components of the installed system such as piping, hangers, nozzles, and tanks or cylinders. Include sequence of testing, time estimate for each test, and sample test data forms. Provide test data forms in a check-off format (pass or fail with space to add applicable test data; similar to the format in NFPA 72), and use them for the preliminary testing and the final testing. Provide test data forms that record the test results and:

a. Identify each test required by NFPA 12 Approval of Installations, NFPA 12 Testing of Systems, NFPA 12 Test and Maintenance Procedures, and herein, to be performed on each component, and describe how the test must be performed.

b. Identify each component as to type, location within the facility, and unique identity within the installed system. Provide necessary floor plan and site plan sheets showing each component location, test location, and alphanumeric identity.

c. Identify all test equipment and personnel required to perform each test.

d. Provide space to identify the date and time of each test. Provide space to identify the names and signatures of the individuals conducting and witnessing each test.

3.6.3 Test Stages

3.6.3.1 Preliminary Tests

****
NOTE: Tailoring options have been used in this paragraph to differentiate requirements between low-pressure and high-pressure systems.
****
****
NOTE: Tailoring has been used in this paragraph to differentiate between Army and Non-Army requirements for who attends the preliminary testing.
****

[Perform a room pressurization test (fan test) in each protected space, separated by zone. Determine the total leakage area present in each tested space. Use these results to ensure that adequate extra carbon-dioxide is included in the supply tank(s) or cylinders to maintain the required concentration for the required duration. Also use these results to ensure that adequate relief venting area is provided to avoid overpressurization of the enclosure upon carbon-dioxide release.

] Ensure that the QFPE, as well as the Supervisor, are in attendance at the preliminary testing and sign off on the certification letter. Ensure that the Designer, as well as the Supervisor, are in attendance at the preliminary testing and sign off on the certification letter. Prior to commencing other required tests, discharge a minimum of 45400 g 100 pounds of carbon-dioxide to demonstrate reliability and proper functioning of pressure-operated switches and discharge of carbon-dioxide gas from each system discharge nozzle. After discharge, clean wire screens at nozzles, when provided. When screens or nozzles show evidence of plugging, discharge an additional 45400 g 100 pounds of carbon-dioxide gas with the nozzles removed prior to continuing on with full system discharge testing. Provide carbon-dioxide required for tests. Individually test each manual release station and other components and accessories to demonstrate proper functioning. Correct deficiencies prior to formal functional and operating tests of the system.Ensure that the QFPE, as well as the Supervisor, are in attendance at the preliminary testing and sign off on the certification letter. Ensure that the Designer, as well as the Supervisor, are in attendance at the preliminary testing and sign off on the certification letter. Prior to commencing other required tests, discharge a minimum of one 34000 g 75 pound cylinder of carbon-dioxide to demonstrate the reliability and proper functioning of each pressure-operated switch and the discharge of carbon-dioxide gas from each system discharge nozzle. After discharge, clean wire screens at nozzles, if provided. If screens or nozzles show evidence of plugging, discharge an additional cylinder of carbon-dioxide gas with the nozzles removed prior to continuing on with full system discharge testing. Provide carbon-dioxide required for tests. Individually test each manual release station and other components and accessories to demonstrate proper functioning. Correct deficiencies prior to formal functional and operating tests of the system.

3.6.3.2 Request for Formal Inspection and Tests

After preliminary testing is complete, provide a letter certifying that the installation is complete and fully operable with the Request for Formal Inspection and Tests. Include the draft Carbon Dioxide System Acceptance Test Report from NFPA 12 as well as the names and titles of the witnesses to the preliminary tests in the letter. Submit request for final test at least [30][_____] days prior to the proposed test date.

3.6.3.3 Final Testing

****

NOTE: The Government's representative to witness final testing may vary by project, by branch, by location, or by any other number of factors. Coordinate with the DFPE to ensure the appropriate Government Representative is specified herein.

****

****

NOTE: Tailoring has been used in this paragraph to differentiate between Army and Non-Army requirements for who attends the final testing.

****

Furnish instruments, labor, and materials required for the tests. Arrange for the Supervisor to conduct the tests. Repeat tests performed during preliminary testing as directed by the [DFPE][Contracting Officer][_____]. If deficiencies are found, make corrections and retest the system to ensure that they are resolved. Costs for witnessing of retesting incurred by the Government and their representatives may be charged to the Contractor at the discretion of the Contracting Officer. Ensure that the final tests are witnessed by the [DFPE][Contracting Officer][_____] and the QFPE.Ensure that the final tests are witnessed by the [DFPE][Contracting Officer][_____] and the Designer. After successful completion of tests, refill the storage tank(s) or cylinders with carbon-dioxide.

3.6.3.4 Additional Tests

When deficiencies, defects, or malfunctions develop during required tests, suspend further testing of the system until proper adjustments, corrections, or revisions have been made to ensure proper performance of the system. When these revisions require more than a[one hour][four hour][one day] delay, notify the Contracting Officer when the additional work has been completed to arrange a new final test of the carbon-dioxide fire-extinguishing system. Repeat tests required prior to final acceptance, unless directed otherwise by the [DFPE][Contracting Officer][_____].

3.6.3.5 Final Test Report

Provide a letter certifying that the installation is complete and fully operable with the Final Test Report. Include the finalized Carbon Dioxide System Acceptance Test Report from NFPA 12 as well as the names and titles of the witnesses to the final tests in the letter. Ensure that the QFPE, as well as the Supervisor, sign off on the letter.Ensure that the Designer, as well as the Supervisor, sign off on the letter. Submit the final test report within [14][_____] days of test completion.

3.6.4 System Acceptance

Following successful completion of final testing of the system, deliver as-built drawings and operation and maintenance instructions (O&M Manuals) to the Contracting Officer for review and acceptance. Submit the drawings and manuals within [14][_____] days after the final testing of the system. Provide at least one set of as-built (marked-up) drawings at the time of, or prior to, the final testing for use in field verification.

3.7 CLOSEOUT ACTIVITIES

3.7.1 Training

3.7.1.1 Instruction of Government Personnel

Instruct Government operating and maintenance personnel, as designated by the Contracting Officer, for a minimum of [eight][_____] total hours covering at least the following for all items of equipment provided under this Contract:

a. Theory of operation.

b. Procedures for start-up, operation, and shutdown.

c. Maintenance instructions.

d. Safety precautions.

e. Test procedures.

f. Field troubleshooting and diagnostic procedures.

g. Repair procedures for field repairs that can be made by replacing plug-in components.

Provide instruction by the manufacturer's technical representative at the project site using the documents specified in the paragraph entitled "Operation and Maintenance Manuals".

3.7.1.2 Recordings

Record all training presented on-site utilizing recording equipment acceptable to the Contracting Officer. Perform recording such that all visual aids are clearly visible and all discussion is clearly understandable. Provide record copies of the recordings to the Contracting Officer within [14][_____] days following completion of training.

[3.7.1.3 Advanced Maintenance Training

****

NOTE: Advanced Maintenance Training is intended for those Installations where the government personnel are going to be responsible for making programming changes to the equipment or installing new equipment without the involvement of a manufacturer's representative. This training is intended to provide those individuals with manufacturer's certification level training to enable them to be

competent to make such changes.
****

Within one year of contract completion, provide [one][two][_____] Government-designated maintenance personnel assigned to the site a complete technical repair training session of [40][_____] hours covering repair of the carbon-dioxide fire-extinguishing system equipment. Include in the training an in-depth explanation and review of the theory of operation, function, description, and troubleshooting of all equipment provided down to the component level. Include a review of manuals, drawings, and parts lists, together with any clarifications required. Ensure that at least one period of eight hours is spent troubleshooting equipment with actual faults being introduced for training purposes. Provide instructional personnel that are certified by the related equipment manufacturer to provide technical instruction services. Transportation, lodging, and meal costs for Government personnel attending this off-site training is not a part of this Contract.

]

-- End of Section --