



NORTHWESTERN UNIVERSITY

MASTER SPECIFICATIONS

Division 21 – FIRE SUPPRESSION

Release 1.0
[March] 2017

Released by:
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Evanston, IL 60208-4301

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NORTHWESTERN UNIVERSITY

PROJECT NAME _____

JOB # _____

FOR: _____

ISSUED: 03/29/2017

MASTER SPECIFICATIONS: DIVISION 21 – FIRE SUPPRESSION

<u>SECTION #</u>	<u>TITLE</u>
21 0000	GENERAL FIRE SUPPRESSION REQUIREMENTS
21 0800	COMMISSIONING OF FIRE SUPPRESSION SYSTEMS
21 1314D	AUTOMATIC SPRINKLER SYSTEMS (DRY-PIPE) (NEW)
21 1314W	AUTOMATIC SPRINKLER SYSTEMS (WET-PIPE SYSTEMS) (NEW)
21 2400CA	CLEAN AGENT CHEMICAL SUPPRESSION SYSTEMS (NEW)
21 2400WC	CHEMICAL SUPPRESSION SYSTEMS (WET CHEMICAL) (NEW)

*** End of List ***

SECTION 21 0000 - GENERAL FIRE SUPPRESSION REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Mechanical sleeve seals.
3. Sleeves.
4. Escutcheons.
5. Grout.
6. Fire-suppression demolition.
7. Concrete bases.
8. Supports and anchorages.
9. New equipment/component bar coding (see 3.7 near end of this section).

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 SUBMITTALS

- A. Welding certificates.
- B. Qualifications for installing and maintenance technicians.

- C. At closeout, Northwestern Maintenance Requirement Forms, see Division 1 for more information.
- D. In addition to any fire suppression system documents that are required to be submitted in other Division 21 sections, drawings are also to be submitted review and approval to the Northwestern University Plumbing Shops and Risk Assessment Offices.
- E. In Microsoft Excel, a complete sprinkler device report is required, which covers all sprinkler devices by location, per building served. Report to include all system components identified on the risers, total number of sprinklers per floor, flow switches, tampers, FDC's, inspectors test valves, standpipes, backflow preventers, gauges, hose connections and cabinets, and all other similar and required components. The University can provide a sample of the report when requested.
- F. Maps: Per the University requirements (and samples can be obtained from them if requested), all system components shall be shown and identified on what the University calls their "Maps." The University will provide cadd floor plans for this use, and system schematics are to be provided as a part of this "mapping" effort. All of the same components as described in item D directly above are required to be shown and noted, as well as the system schematics that are required. PDF and cadd electronic files are required, as well as two (2) sets of 11x17 paper sets, organized and bound in a University approved method. For the cadd files, the drawings shall be built in layers so that individual similar entities are layered together. Separate sets are required per building.

1.5 QUALITY ASSURANCE AND COORDINATION

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Fire-Suppression Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
- D. Comply with applicable codes, standards, and requirements of authorities having jurisdiction. For the Chicago campus, the Chicago Building Code shall be consulted for deviations from NFPA standards.
- E. Comply with the Illinois Building Code and Fire Code, and required references, the City of Chicago Building Code, Fire Prevention Code, and required references, and with all other requirements of the local Authority Having Jurisdiction (AHJ). In cases where these requirements deviate from the project contract documents, the most stringent shall govern.
- F. System Designs: Shall be provided by a properly qualified and licensed Professional Engineer.
- G. All system designs, materials, and installations shall meet applicable FM Global requirements.

- H. Comply with most current edition of the Northwestern University Design Standards.
- I. Shutdown Coordination: All shutdowns shall be requested from the respective University Project Manager. All shutdowns must have a Shutdown Request Form filled out and submitted to the appropriate University Trade Shop 48 hours in advance. Emergency situations will be handled on a case-by-case basis.

1.6 SPECIAL WARRANTIES

- A. 5 year service warranty from date of project handover to Owner at beneficial occupancy, see Division 01 for more information. These warranties shall also include a 4 hour response to emergency service calls, parts and labor, and maintenance per all applicable NFPA codes and standards, and per City of Evanston and City of Chicago requirements (based on project location).

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS:

- A. All equipment and materials shall be furnished in strict accordance with the instructions of the manufacturer of the equipment named, according to NFPA and FM Global requirements and standards, and according to Specification requirements. Bids shall be based upon one of the manufacturers specified.
- B. Where multiple manufacturers are named the drawings and specifications are based on the requirements and layouts for the equipment of the first named manufacturer, any changes required by the use of other named manufacturers such as revisions to foundations, bases, piping, controls, wiring, openings, and appurtenances shall be made by the Contractor at no additional cost to the University.
- C. As system flows, tampers, etc need to be connected to facility fire alarm system (by the FA contractor) and the University DDC/SCADA/BAS system(s) (by the Div. 25 contractor), the flows, tampers, and other similar devices are to be furnished with two sets of contacts so that the fire alarm contractor can tie to one set and the Division 25 contractor can tie to the other set.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 21 Sections for pipe, tube, and fitting materials and joining methods. No cast fittings allowed for new piping, all must be malleable iron or steel (for couplings), as applicable with specific piping system.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 21 Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.
- E. Welding Filler Metals: Comply with AWS D10.12.

2.4 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
- B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
- C. Pressure Plates: Stainless steel. Include two for each sealing element.
- D. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.

2.6 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, and tube, that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: Polished chrome-plated.

2.7 GROUT

- A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 FIRE-SUPPRESSION DEMOLITION

- A. Refer to Division 01 Section covering cutting and patching and the Division 02 Section covering demolition for general demolition requirements and procedures.
- B. For renovations/additions, disconnect, demolish, and remove fire-suppression systems, equipment, and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Piping to Be Abandoned in Place: Not allowed, all piping no longer needed is to be removed.
 - 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 21 Sections specifying specific systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Select system components with pressure rating equal to or greater than system operating pressure in accordance with applicable NFPA document.
- K. Install escutcheons for penetrations of walls, ceilings, and floors.
- L. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- M. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- N. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- O. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- P. Verify final equipment locations for roughing-in.
- Q. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- R. For all systems utilizing water from a campus main, all connections to same shall include a properly rated check valve and isolation valve, in addition to any required backflow preventers, etc.

- S. For water based suppression systems, for multi-story buildings, each branch off a riser per floor, is to have a properly rated check valve.

3.3 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 21 Sections specifying specific systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube ends. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.4 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 - 7. Use 3000-psi 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete"

3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire-suppression materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.6 GROUTING

- A. Mix and install grout for fire-suppression equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

3.7 NEW WORK BAR CODING

- A. Coordinate with University, and bar code all new Division 21 equipment and components for them, according to their requirements. Requirements include, but not limited to, being iPad compatible, have the ability to call up maps of the areas on bar code scan, must have safeguards built in to flag missing extinguishers and/or other items, and the devices on the maps need to be color coded based on inspection status.

3.8 SYSTEM TESTING

- A. All system testing to meet local jurisdiction and fire fighting authority, applicable NFPA codes and standards (NFPA 10, 101, 2001, 96, and other as applicable), and FM Global requirements. Testing methods (initial installation for acceptance and then weekly, monthly, quarterly, semi-annually, and annually as required) to be included, and tests to be used are ones that actually flow water (depending on exactly what type of system or component is being tested).

END OF SECTION 21 0000

SECTION 21 0800 - COMMISSIONING OF FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. General

1. Work under this contract shall meet the requirements of Division 01, General Requirements, Conditions of Contract, and Supplementary Conditions. This specification covers commissioning of the fire suppression system for the entire structure.
2. All labor and materials shall be furnished to complete commissioning of the fire suppression systems specified herein.

B. Commissioning work shall be organized and structured to verify that all fire suppression system and equipment have been properly designed and installed and function together correctly to meet OPR (Owner Project Requirements) and BOD (Basis of Design). Commissioning shall be in accordance with NFPA 3, Recommended Practice for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems, 2012 edition.

C. The Commissioning Authority (CxA) retained by Owner shall have responsibility for coordinating and directing the required steps of the commissioning process.

D. Fire suppression system installation, start-up, testing, preparation of O&M Manuals, training shall be the responsibility of the fire suppression contractors. Oversight of the observation, coordination, verification, and commissioning shall be the responsibility of the CxA. The CxA process does not relieve the fire suppression contractors of obligation to complete all portions of the work in a satisfactory manner and ensure systems are fully operational.

E. Refer to Division 01, Section 01 9113, for a full list of commissioning related definitions. A few critical definitions are included below:

1. *Commissioning*. A systematic process that provides documented confirmation that specific and interconnected fire and life safety systems function according to the intended design criteria set forth in the project documents and satisfy the owner's operational needs, including compliance requirements of any applicable laws, regulations, codes, and standards requiring fire and life safety systems.
2. *Commissioning Authority (CxA)*. The qualified person, company, or agency that plans, coordinates, and oversees the entire Cx process.
3. *Commissioning Plan*. The document prepared for each project, which identifies the processes and procedures necessary for a successful Cx process.
4. *Commissioning Record*. The complete set of commissioning documentation for the project, which is turned over to the owner at the end of the construction phase.
5. *Functional Testing*. Tests performed to verify compliance with manufacturers' specifications, applicable codes and standards, and the project BOD and OPR.

F. The purpose of the commissioning is to verify the design intent, develop the OPR and BOD, to verify that the OPR and BOD are verified through testing, and to provide training.

- G. The Commissioning Team shall be made up of representatives from the Owner, Design Team, General Contractor (GC), manufacturers, and construction trades. The trades represented on the Commissioning Team shall include, but not be limited to: Mechanical (including sheet metal and piping), Integrated Automation, Electrical, Plumbing, Fire Suppression and other specialty trades as necessary; fitting, controls, test and balance, and electrical. The lead person for each trade who will actually perform or supervise the work is to be designated as the representative to the Commissioning Team. Responsibility for various steps of the Commissioning Process shall be divided among the members of the Commissioning Team, as described in this section.

1.2 RELATED SECTIONS

- A. Division 01 Section 01 9113 - General Commissioning Requirements
- B. Division 22 Section 22 0800 – Commissioning of Plumbing Systems
- C. Division 23 Section 23 0800 – Commissioning of HVAC Systems
- D. Division 25 Section 25 0800 – Commissioning of Integrated Automation
- E. Division 26 Section 26 0800 – Commissioning of Electrical Systems
- F. Individual Division 01, 21, 22, 23, 25, and 26 sections contain requirements related to the Commissioning Process.

1.3 QUALITY ASSURANCE

- A. The following references should be used to develop and implement the commissioning program as appropriate:
 - 1. NFPA 3, Recommended Practice for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems.
 - 2. ASHRAE Guideline 0, The Commissioning Process.

1.4 ROLES AND RESPONSIBILITIES

- A. Refer to Section 01 9113 for Commissioning Authority, Owner, Architect, and General Contractor roles and responsibilities.
- B. Refer to Section 22 0800 for plumbing contractor roles and responsibilities.
- C. Refer to Section 23 0800 for mechanical contractor roles and responsibilities.
- D. Refer to Section 25 0800 for integrated automation contractor roles and responsibilities.
- E. Refer to Section 26 0800 for electrical contractor roles and responsibilities.
- F. Design Team
 - 1. Provide the Owners Project Requirements (OPR).
 - 2. Provide documentation of initial design concepts and Design Intent based on Owner's program.
 - 3. Provide fire suppression system design parameters and obtain approval of Owner.

4. Prepare contract documents incorporating Commissioning Specification requirements and description of the electrical systems.
5. The Design Team shall specify and verify adequate maintenance accessibility for each piece of equipment in shop drawings and the actual installation.
6. Periodic inspections as part of the Design Team's contract with the Architect and/or Owner.
7. Review and approve submittals.
8. Participate in commissioning meetings.
9. Review Pre-functional Checklists and Functional Performance Test procedures submitted by the Commissioning Authority.
10. Prepare punch lists.
11. Review as-built records as required by contract documents. Issue a report noting deficiencies requiring correction to the Commissioning Authority.
12. Review and comment on final commissioning report.

G. Fire Suppression Contractor

1. Include cost to complete commissioning requirements for fire suppression systems in the contract price.
2. Include requirements for submittal data, O&M data, and training in each purchase order or sub contract written.
3. Ensure cooperation and participation of all subcontractors.
4. The building fire suppression systems shall be installed, tested, commissioned, and maintained in accordance with commissioning process of NFPA 3, *Recommended Practice for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems*.
5. Ensure participation of major equipment manufacturers in appropriate training and testing activities.
6. Attend Construction Phase coordination meeting scheduled by the Commissioning Authority.
7. Conduct fire suppression system orientation and inspection when equipment is set.
8. Respond to (in writing) and address items documented in the Contractor Commissioning Issues Log.
9. Notify the GC a minimum of two weeks in advance of system start-up and testing, so CxA may be on site to witness.
10. Submit copies of all test results to the CxA.
11. Complete Pre-Functional Checklists for all equipment.
 - a. If no other system is agreed upon by Commissioning Team, Fire Suppression Contractor shall be responsible for completion of Pre-Functional Checklists for all equipment for which it issued a purchase order.
 - b. Fire Suppression Contractor shall coordinate completion of Pre-Functional Checklists with all other contractors that have made connections to equipment for which it issued a purchase order.
 - c. Remedy any deficiencies identified in Pre-Functional Checklists and notify CxA in writing that deficiencies have been addressed.
12. Assist the Commissioning Authority in all Pre-Functional Checklist verifications, Functional Performance Tests, and Integrated Systems testing.
13. Prepare preliminary schedule for fire suppression system orientation and inspections, O&M manual submission, training sessions, pipe system testing, flushing and cleaning, equipment start up, and task completion for use by the GC and Commissioning Authority. Update schedule as appropriate throughout the construction period.
14. Develop an individual system test plan, including acceptance and integrated testing.
15. Conduct Integrated System testing. Demonstrate the performance of the systems, including integration.

16. Keep drawings updated as changes in the field are made, and review with the GC and Commissioning Authority.
17. Gather O&M data on all equipment, and assemble in binders as required by the Commissioning Specification. Submit to GC for review prior to the completion of construction. Submit in digital media/electronic format (flash drive, CD, DVD).
18. Submit training syllabus for approval to Commissioning Authority.
19. Participate in, and schedule vendors and Contractors to participate in the training sessions as set up by the GC. Provide site-specific training information on digital media/electronic format (flash drive, CD, DVD). If training is videotaped, provide on digital media/electronic format (flash drive, CD, DVD).
20. Provide written notification to the General Contractor and Commissioning Authority that the following work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-systems are functioning as required.
 - a. Fire Alarm Notification Panel
 - b. Remote Fire Alarm Notification Panel
 - c. Smoke Control Systems
 - d. Automatic Sprinkler Systems
 - e. Standpipe and Hose Systems
 - f. Water Spray Fixed Systems
 - g. Water Mist Systems
 - h. Foam Systems
 - i. Water Tanks
 - j. Private Fire Service Mains
 - k. Chemical Fire Protections Systems
 - l. Explosion Prevention Systems
 - m. Smoke Detectors
 - n. Carbon Monoxide Detectors
 - o. Duct Mounted Smoke Detectors
 - p. Wet-Pipe Sprinkler System
 - q. Dry-Pipe Sprinkler System
 - r. Fire Pump
 - s. Jockey Pump
 - t. Control valves, fittings, fire stops, and any other materials or equipment required in the system.
21. Provide a complete set of as-built records to the GC. Hard Copy and Electronic Format (Flash Drive, CD, DVD, etc....) are required.

H. Equipment Manufacturers and Miscellaneous Contractors

1. Include cost for commissioning requirements in the contract price.
2. Provide submittals, and appropriate O&M manual section(s).
3. Attend initial commissioning coordination meeting scheduled by the Commissioning Authority.
4. Participate in training sessions as scheduled by the GC.
5. Demonstrate performance of equipment as applicable.

1.5 SCOPE OF WORK

A. Commissioning work of Division 21 shall include, but not be limited to:

1. Testing and start-up of the equipment.
2. Completion of Pre-Functional Checklists.

3. Cooperation with the Commissioning Authority.
 4. Providing qualified personnel for participation in commissioning tests.
 5. Providing equipment, materials, and labor as necessary to correct construction and/or equipment deficiencies found during the Commissioning Process.
 6. Providing operation and maintenance manuals and as-built drawings to the Commissioning Authority for verification.
 7. Providing training and demonstrations for the systems specified in this Division.
- B. The work included in the Commissioning Process involves a complete and thorough evaluation of the operation and performance of all components, systems, and sub-systems. The following equipment and systems shall be evaluated:
- a. Fire Alarm Notification Panel
 - b. Remote Fire Alarm Notification Panel
 - c. Smoke Control Systems
 - d. Stair pressurization systems
 - e. Smoke proof enclosure ventilation systems
 - f. Fire suppression system controllers
 - g. Automatic Sprinkler Systems
 - h. Standpipe and Hose Systems
 - i. Water Spray Fixed Systems
 - j. Water Mist Systems
 - k. Foam Systems
 - l. Water Tanks
 - m. Private Fire Service Mains
 - n. Chemical Fire Protections Systems
 - o. Explosion Prevention Systems
 - p. Smoke Detectors
 - q. Carbon Monoxide Detectors
 - r. Duct Mounted Smoke Detectors
 - s. Wet-Pipe Sprinkler System
 - t. Dry-Pipe Sprinkler System
 - u. Fire Pump
 - v. Jockey Pump
 - w. Meter and Gauges
 - x. Control valves, fittings, fire stops, and any other materials or equipment required in the system.
- C. Timely and accurate documentation is essential for the Commissioning Process to be effective. Documentation required as part of the Commissioning Process shall include but not be limited to:
1. Commissioning Process Reports, which may include the following:
 - a. Commissioning Field Reports
 - b. Design Team Issues Log
 - c. Contractor Commissioning Issues Log
 - d. Meeting Minutes
 2. Pre-start, and start-up procedures
 3. Pre-Functional Checklists
 4. Functional Performance Tests
 5. Integrated System Testing
 6. Training agenda and materials
 7. As-built records

8. Final commissioning report
9. Operation and maintenance (O&M) manuals

D. Detailed testing may be performed on all installed equipment and systems to ensure that operation and performance conform to contract documents. All tests shall be witnessed by the Commissioning Authority. The following testing is required as part of the Commissioning process:

1. Pre-Functional Checklists (PFC) are comprised of a full range of checks and tests to determine that all components, equipment, systems, and interfaces between systems operate in accordance with contract documents. Verification is completed by the Division 21, 22, 23, 25, and 26 contractors and documented using Pre-Functional Checklists.
2. Functional Performance Tests (FPT) shall determine if the fire suppression system is operating in accordance with the design intent. This includes all operating modes, interlocks, control responses, and specific responses to abnormal or emergency conditions.
3. Integrated System Testing shall verify the interconnections between the life safety and fire suppression systems function properly.

E. Comprehensive training of O&M personnel shall be performed by the Fire Suppression Contractor, and where appropriate, by other sub-contractors, and vendors prior to turnover of building to the owner. The training shall include classroom instruction, along with hands-on instruction on the installed equipment and systems. Training shall be recorded on digital media.

F. Submission of a digital copy of site-specific software for fire suppression and life safety systems that is current with the installed system.

1.6 DOCUMENTATION

A. The Commissioning Authority shall oversee and maintain the development of the document process. The GC shall facilitate project documentation through the web-based commissioning software. The commissioning documentation shall include, but not be limited to, the following:

1. Commissioning Plan
2. Commissioning Schedule
3. Document Request Log
4. Commissioning RFIs
5. Commissioning Field Reports on the WCxS
6. Design Team Issues Log on the WCxS
7. Contractor Commissioning Issues Log on the WCxS
8. Pre-Functional Checklists on the WCxS
9. Inspection Test Reports
10. Functional Testing
11. Integrated System Testing

B. See 01 9113 for additional information on the commissioning documentation.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. The appropriate Contractor(s) shall furnish all special tools and equipment required for testing during the commissioning process. A list of all tools and equipment to be used during commissioning shall be submitted to the Commissioning Authority for approval. All the test equipment to be utilized shall be calibrated as per National Fire Protection Agency (NFPA) and written manufacturer recommendations. The owner shall furnish necessary utilities for the Commissioning Process.

2.2 TEST EQUIPMENT – PROPRIETARY

- A. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the Commissioning Process as needed. Proprietary test equipment (and software) shall become the property of the owner upon completion of the Commissioning Process.

PART 3 - EXECUTION

3.1 GENERAL

- A. A pre-construction meeting of all Commissioning Team members shall be held at a time and place designated by the owner. The purpose shall be to familiarize all parties with the Commissioning Process, and to ensure that the responsibilities of each party are clearly understood.
- B. The Contractor shall complete all phases of work so the systems can be started, tested, balanced, and commissioning procedures undertaken. This includes the complete installation of all equipment including pipe, fittings, pipe supports, valves, and controls as indicated on the contract documents, and implementing all corrective actions, clarifications, and change orders.
- C. A Commissioning Plan shall be developed by the Commissioning Authority. The Contractor shall assist the Commissioning Authority in preparing the Commissioning Plan by providing all necessary information pertaining to the actual equipment and installation. If contractor-initiated system changes have been made that alter the Commissioning Process, the Commissioning Authority shall notify the Owner.
- D. Acceptance procedures are normally intended to begin prior to completion of a system and/or sub-systems, and shall be coordinated by fire suppression contractor. Start of acceptance procedures before system completion does not relieve the contractor from completing those systems as per the schedule.

3.2 PARTICIPATION IN COMMISSIONING

- A. The Contractor shall provide skilled technicians to start-up and debug all systems within Division 21. These same technicians shall be made available to assist the Commissioning Authority in completing the commissioning program. Work schedules, time required for testing, etc., shall be requested by the Commissioning Authority and coordinated by the contractor. Contractor shall ensure that the qualified technician(s) are available and present during the agreed upon

schedules and of sufficient duration to complete the necessary tests, adjustments, and/or problem resolutions.

- B. System performance problems and discrepancies may require additional technician time, CxA time, reconstruction of systems, and/or replacement of system components. The additional technician time shall be made available for subsequent commissioning periods until the required system performance is obtained.
- C. The CxA reserves the right to question the appropriateness and qualifications of the technicians relative to each item of equipment, system, and/or sub-system. Qualifications of technicians shall include expert knowledge relative to the specific equipment involved and a willingness to work with the CxA. Contractor shall provide adequate documentation and tools to start up and test the equipment, system, and/or sub-system.

3.3 DEFICIENCY RESOLUTION

- A. In some systems, maladjustments, misapplied equipment, and/or deficient performance under varying loads will result in additional work being required to commission the systems. This work shall be completed under the direction of the Owner, with input from the contractor, equipment manufacturer, and Commissioning Authority. Whereas all members shall have input and the opportunity to discuss, debate, and work out problems, the Owner shall make final determination over any additional required work to achieve performance.
- B. Corrective work shall be completed in a timely fashion to permit the completion of the Commissioning Process. Experimentation to demonstrate system performance may be permitted. If the Commissioning Authority deems the experimentation work to be ineffective or untimely as it relates to the Commissioning Process, the Commissioning Authority shall notify the Owner, indicating the nature of the problem, expected steps to be taken, and suggested deadline(s) for completion of activities. If the deadline(s) pass without resolution of the problem, the Owner reserves the right to obtain supplementary services and/or equipment to resolve the problem. Costs incurred to solve the problems in an expeditious manner shall be the contractor's responsibility.
- C. The Owner's contract with the Commissioning Authority includes one (1) Functional Performance Tests and one (1) retest for each piece of equipment or system included in the commissioning scope. Commissioning Authority time and expenses required for retests beyond two, if required, due to incomplete installation or otherwise, will be paid by the Owner and reimbursed by the contractor.
- D. The Owner's contract with the Commissioning Authority includes one (1) Integrated System Testing and one (1) retest included in the commissioning scope. Commissioning Authority time and expenses required beyond one (1) retest, if required, due to incomplete installation or otherwise, will be paid by the Owner and reimbursed by the contractor.

3.4 ADDITIONAL COMMISSIONING

- A. Additional commissioning activities may be required after system adjustments, replacements, etc., are completed. The contractor(s), manufacturers, and Commissioning Authority shall include a reasonable reserve to complete this work as part of their contractual obligations.

3.5 CONSTRUCTION PHASE OBSERVATION

A. Scope of Construction Phase Observation

1. The Commissioning Authority will conduct periodic observations during the Construction Phase to monitor progress and compliance with the design intent and contract documents. It is the responsibility of the contractor to address the issues noted on the Issues Log and notify Commissioning Authority of completion.
2. Commissioning Authority observations will coincide with Design Team observations and are not intended to take the place of this work.

B. Documentation and Reporting

1. Issues identified by the Commissioning Authority during Construction Phase will be documented on the Contractor Commissioning Issues Log and distributed to Commissioning Team members.
2. Progress during the Construction Phase will also be documented by the Commissioning Authority using Commissioning Process Reports.

3.6 ACCEPTANCE PROCEDURES

A. Pre-functional Checklists

1. Scope of Pre-functional Checklists

- a. Tests and verifications included in the Pre-functional Checklists shall determine if all components, equipment, systems, and interfaces between systems are installed and are ready to operate in accordance with contract documents.

2. Documentation and Reporting Requirements

- a. Pre-Functional Checklists shall be provided for each component, piece of equipment, system, and sub-system, including all interfaces, interlocks, etc. Each item to be tested shall have a different entry line with space provided for comments. The checklists will include spaces for each party to sign off on.
- b. The checklist shall equipment characteristics and the installation status of the component or system.
- c. The commissioning authority shall review and approve the completed checklist before scheduling functional performance testing.
- d. Completed checklists shall be submitted to the Commissioning Authority for acceptance and inclusion in the commissioning report.

3. Acceptance of Pre-Functional Checklists

- a. The Commissioning Authority will select, at random, 10 percent of the checklists for verification.
- b. If 10 percent or more of the checklists are found to be inaccurate for each system or equipment type, all of the checklists for that system or equipment type will be rejected. Complete, accurate checklists will need to be resubmitted.

B. Functional Testing

1. Scope of Functional Testing

- a. Individual system functional operation and acceptance as required in applicable NFPA standards or AHJ installation standards tests.

2. Submittals

- a. Detailed procedures for each series of tests will be developed by the Commissioning Authority for review and acceptance by the GC and Owner. The procedures shall include samples of the data sheets that will be part of the reports.

3. Functional Test Procedures

- a. Shall verify the intended operation of components and systems as required by manufacturer installation, codes, standards, and project specifications.

4. Documentation and Reporting Requirements

- a. All measured data, data sheets, and a comprehensive summary, describing the operation of the fire suppression system at the time of testing shall be submitted to the Commissioning Authority.
- b. A preliminary functional test report shall be prepared by the Commissioning Authority and submitted to the Design Team for review. Any identified deficiencies need to be evaluated by the Design Team and General Contractor to determine if they are part of the contractor's or sub-contractor's contractual obligations. Construction deficiencies shall be corrected by the responsible contractor(s), and the specific Functional Performance Test repeated.
- c. If it is determined that the fire suppression system is constructed in accordance with the contract documents, and the performance deficiencies are not part of the contract documents, the Owner must decide whether any required modifications needed to bring the performance of the fire suppression system up to the finalized design intent shall be implemented, or if the test shall be accepted as submitted. If corrective work is performed, the owner shall determine if a portion or all required Functional Performance Tests should be repeated, and a revised report submitted.

C. Integrated System Testing

1. Scope of Integrated System Testing

- a. Verification of completeness and integrity of building construction
- b. Integrated System Testing should demonstrate that the final integrated system installation complies with the specific design objectives for the project and applicable codes and standards.
- c. Integrated System Testing should verify the interconnections between fire suppression and life safety systems function properly.
- d. Written documentation of the testing is required.
- e. Switch connections to fire alarms should be tested in accordance with NFPA 72, National Fire Alarm and Signaling Code.
- f. Control circuits requiring electrical power shall be tested for presence of operating voltage.

- g. Loss of power to monitored circuits should be tested to confirm signal receipt at one of the following:
 - 1) A constantly attended location at the premises
 - 2) A monitoring station as described in NFPA 731, Standard for Installation of Electronic Premises Security Systems, Chapter 9
 - 3) A supervising station as described in NFPA 72, National Fire Alarm and Signaling Code.

- h. Integrated testing of data sharing systems should document the following:
 - 1) Completion of acceptance testing for each component system
 - 2) Verification of data transfer between component systems
 - 3) Test of visual and audible signal upon loss of communication
 - 4) Test of degrade mode for each component system
 - 5) Proper function of integrated data sharing systems

- i. The following is a list of subsystems that will be interconnected in the integrated system for the project:
 - 1) Fire alarm system
 - 2) Emergency communication systems
 - 3) Building automation management system
 - 4) Means of egress systems and components
 - 5) Heating, ventilating, and air conditioning (HVAC) system
 - 6) Gas detection system
 - 7) Normal, emergency, and standby power systems
 - 8) Automatic sprinkler systems
 - 9) Fixed fire suppression and control systems
 - 10) Automatic operating doors and closures
 - 11) Smoke control and management systems
 - 12) Explosion prevention and control systems
 - 13) Elevator and pedestrian movement systems
 - 14) Security systems
 - 15) Commercial cooking operations

- 2. Submittals
 - a. Detailed procedures for each series of tests will be developed by the Commissioning Authority for review and acceptance by the GC and Owner. The procedures shall include samples of the data sheets that will be part of the reports.

- 3. Integrated System Test Procedures
 - a. The Commissioning Authority shall witness the Integrated System Test.
 - 1) Set the system equipment (i.e. water heater, pumps, ejectors, etc.) into the operating mode to be tested (i.e. normal shut-down, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
 - 2) If during a test an operating deficiency is observed, appropriate comments will be added to the Test Procedure form and the Issues Log.

- b. If deficiencies are identified during Integrated System Testing, the General Contractor will be notified and action taken to remedy the deficiency. The final Integrated System Testing Procedure forms will be reviewed by the Commissioning Authority to determine if testing is complete and the system is functioning in accordance with the contract documents.
4. Documentation and Reporting Requirements
 - a. All measured data, data sheets, and a comprehensive summary, describing the operation of the plumbing system at the time of testing shall be submitted to the Commissioning Authority.
 - b. A preliminary Integrated System Test report shall be prepared by the Commissioning Authority and submitted to the Design Team for review. Any identified deficiencies need to be evaluated by the Design Team and General Contractor to determine if they are part of the contractor's or sub-contractor's contractual obligations. Construction deficiencies shall be corrected by the responsible contractor(s), and the specific Functional Performance Test repeated.
 - c. If it is determined that the fire suppression system is constructed in accordance with the contract documents, and the performance deficiencies are not part of the contract documents, the Owner must decide whether any required modifications needed to bring the performance of the Fire suppression system up to the finalized design intent shall be implemented, or if the test shall be accepted as submitted. If corrective work is performed, the owner shall determine if a portion or all required Functional Performance Tests should be repeated, and a revised report submitted.

3.7 SYSTEMS MANUAL:

- A. The Systems Manual shall be submitted in paper AND/OR electronic format and shall contain the following major sections:
 1. System Descriptions:
 - a. Title sheet including the complete name and address of the project and the complete name and address of the installing contractor (including telephone number for emergency service)
 - b. Complete table of contents
 - c. System design intent documentation
 - d. Complete list of equipment
 - e. List of equipment suppliers and/or manufacturers
 - f. Operation and maintenance instructions for major components
 - g. Inspection and test reports
 - h. Recommend spare parts
 - i. Riser diagrams or schematic drawings
 - j. "As-built" drawings and calculations
 - k. Fire Alarm System Record of Completion.
 - l. Point to Point Wiring Diagrams
 - m. Individual Device Interconnection Drawings
 - n. Copy of Original Equipment Submittals
 - o. Manufacturer's Proper Testing and Maintenance Requirements
 - p. Warranty
 - q. Other special requirements of the installation specification or installation such as valve tags and charts, hydraulic data nameplate information (for sprinkler systems)

3.8 SYSTEMS TRAINING:

- A. Submit Training Syllabus to Commissioning Authority for approval. Training syllabus shall be submitted a minimum of fourteen (14) business days prior to intended training date(s). Training shall not occur until training syllabus has been approved and all Commissioning Authority comments have been addressed and agreed by the Commissioning Authority. Any training sessions occurring not complying with above statements will not be consider complying with training requirements.
- B. Record site-specific training sessions on digital media/electronic format (flash drive, CD, DVD). Training sessions recorded shall be clearly audible, properly camera framed, and camera supported (tripod). Training session's not audible, inconsistent and distracting camera movement or other issues will have to be redone at contractor cost. Commissioning Authority has final approval of the quality of recorded digital media. Generic training videotapes can be submitted as supplementary and supporting education materials but cannot be submitted as the required primary site-specific training session.
- C. The Fire Suppression Contractor, and appropriate sub-contractors, shall provide comprehensive systems instruction on building systems prior to delivery. The instruction shall include classroom instruction delivered by competent instructors based upon the contents of the Systems Manual. Emphasis shall be placed upon overall systems diagrams and descriptions, and how system components interact. The classroom instruction shall also include detailed equipment instruction by qualified manufacturer's representatives for which operating instructions are provided. The manufacturer's representative training shall emphasize operating instructions and preventive maintenance as described in the Systems Manual. At a minimum, the training sessions shall cover the following items:
1. Types of installed systems
 2. Theory of operation
 - a. Design intent
 - b. Emergency conditions and procedures
 - c. Comfort conditions
 - d. Energy efficiency
 - e. Other issues important to facility operation
 3. System operations
 4. Use of control system
 - a. Sequence of operation
 - b. Problem indicators
 - c. Diagnostics
 - d. Corrective actions
 5. Service, maintenance, diagnostics and repair
 6. Use of reports and logs
 7. Troubleshooting, investigation of malfunctions, and determining reasons for the problem
- D. Each classroom training period shall be followed by an inspection, explanation, and demonstration of the system by the instructors. The applicable equipment shall be demonstrated including system startup and shutdown, with the exception of sprinkler systems.
- E. The contractor shall be responsible for organizing, arranging, and delivering this instruction in an efficient and effective manner on a schedule agreeable to the Owner.

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- F. The contractor shall provide, at or before substantial completion, a proposed agenda and schedule of the above training for approval by the Commissioning Authority and the Owner.

END OF SECTION

SECTION 21 1314D - AUTOMATIC SPRINKLER SYSTEMS (DRY-PIPE)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 21 0000, "General Fire Suppression Requirements."

1.2 SUMMARY

- A. Section Includes:
 - 1. Aboveground fire protection pipe, fittings, and specialties inside the building from 1'-0" above finished floor, 1'-0" inside the exterior wall, or connection provided in the domestic water line as shown on the drawings.
 - 2. Fire-protection valves, and compressors.
 - 3. Fire-department connections.
 - 4. Sprinkler specialty pipe fittings.
 - 5. Sprinklers.
 - 6. Alarm devices.
 - 7. Pressure gages.
 - 8. Backflow preventers.

1.3 SYSTEM DESCRIPTIONS

- A. Dry-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing dedicated compressed air. Opening of sprinklers releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into piping and discharges from sprinklers that are open.

1.4 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a properly licensed and qualified professional engineer, using performance requirements and design criteria indicated. Professional Engineer shall seal (stamp) hydraulic calculations and sprinkler system drawings. Professional Engineer shall be registered in the State of Illinois.
 - 1. The Contractor shall perform a flow test in accordance with NFPA and with FM Global or obtain water design data from the Local Water Department if data is not shown on the drawings.
- C. Sprinkler system design shall be approved by authorities having jurisdiction.

1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
2. Sprinkler Occupancy Hazard Classifications, densities, and head spacing shall be as indicated on the drawings.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For dry-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.
 1. Wiring Diagrams: For power, signal, and control wiring.
- C. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Qualification Data: For qualified Installer and Professional Engineer.
- E. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- F. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- G. Field quality-control reports.
- H. Operation and maintenance data.
- I. At closeout, Northwestern University Maintenance Requirement Forms, refer to Division 01 for more information.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications:
 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified Professional Engineer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. NFPA Standards and Other Requirements: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 1. NFPA 13, "Installation of Sprinkler Systems."
 2. NFPA 14, "Standpipe and Hose Systems."

3. NFPA 70, "National Electrical Code."
 4. NFPA 72, "National Fire Alarm and Signaling Code."
 5. NFPA 291, "Fire Flow Testing and Marking of Hydrants."
 6. NFPA 1963, "Fire Hose Connections."
 7. Comply with the Illinois Building Code and Fire Code, and required references, the City of Chicago Building Code, Fire Prevention Code, and required references, and with all other requirements of the local Authority Having Jurisdiction (AHJ).
- D. Comply with FM Global requirements for general installation of systems, prevention and control of internal corrosion in automatic sprinkler systems, installations in any residential occupancies, for dry pipe, deluge, and pre-action valves and accessories, for system inspections, testing and maintenance, for pipe friction losses for hydraulics of fire protection systems, for pressure reducing valves for fire protection service, for cross connections, for fire protection pumps, for installation/maintenance of fire service mains, for standpipes and hose systems, and for fire protection water demand for non-storage sprinkled properties.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article at the end of this Section for applications of pipe, tube, and fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 STEEL PIPE AND FITTINGS

- A. Standard Weight, Galvanized-Steel Pipe: ASTM A 53 Schedule 40. Pipe ends may be factory or field formed to match joining method.
- B. Schedule 30, Galvanized-Steel Pipe: ASTM A 135; ASTM A 795/A 795M; or ASME B36.10M, wrought steel; with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.
- C. Thinwall Galvanized-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.
- D. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
- E. Galvanized, Steel Couplings: ASTM A 865, threaded.
- F. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- G. Malleable- or Ductile-Iron Unions: UL 860.
- H. Plain-End-Pipe Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn or screwed retainer pin to secure pipe in fitting.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Anvil International, Inc.
- b. Shurjoint Piping Products.

I. Grooved-Joint, Steel-Pipe Appurtenances:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Corcoran Piping System Co.
 - c. Shurjoint Piping Products.
 - d. Tyco Fire & Building Products LP.
 - e. Victaulic Company.
- 2. Pressure Rating: 175 psig minimum.
- 3. Galvanized, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
- 4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick.
 - 1. Class 125, Flat-Face Flanges: Full-face gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

2.4 LISTED FIRE-PROTECTION VALVES

- A. General Requirements:
 - 1. Valves shall be UL listed or FM approved, and meet FM Global requirements.
 - 2. Minimum Pressure Rating: 175 psig.
- B. Check Valves:
 - 1. Standard: UL 312
 - 2. Pressure Rating: 250 psig minimum.
 - 3. Type: Swing check.
 - 4. Body Material: Cast iron.
 - 5. End Connections: Flanged or grooved.
- C. Bronze OS&Y Gate Valves:
 - 1. Standard: UL 262.
 - 2. Pressure Rating: 175 psig.
 - 3. Body Material: Bronze.
 - 4. End Connections: Threaded.
- D. Iron OS&Y Gate Valves:

1. Standard: UL 262.
2. Pressure Rating: 250 psig.
3. Body Material: Cast or ductile iron.
4. End Connections: Flanged or grooved.

E. Ball Valves 2" and smaller:

1. Standard: UL 1091.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Bronze.
4. End Connections: Threaded.

F. Indicating-Type Butterfly Valves (preferred):

1. Standard UL 1091.
2. Pressure Rating: 175 psig minimum.
3. Valve Type: Butterfly.
4. Body Material: Cast or ductile iron.
5. End Connections: Flanged, grooved, or wafer.
6. Valve Operation: Integral electrical, 115-V ac, prewired, single-circuit, supervisory switch indicating device.

2.5 TRIM AND DRAIN VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Minimum Pressure Rating: 175 psig.

2.6 SPECIALTY VALVES AND COMPRESSORS

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Minimum Pressure Rating: 175 psig.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Dry-Pipe Valves and Compressors:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Reliable Automatic Sprinkler Co., Inc.
 - b. Victaulic Company.
 - c. Viking Corporation.
2. Standard: UL 260
3. Design: Differential-pressure type.

4. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
5. Air Compressor:
 - a. Standards: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 - b. Motor Horsepower: Fractional.
 - c. Power: 120-V ac, 60 Hz, single phase, from normal/emergency circuit.
 - d. Type: Tank, and dedicated for this duty.

2.7 FIRE-DEPARTMENT CONNECTIONS

A. Flush-Type, Fire-Department Connection:

1. Standard: UL 405.
2. Type: Flush, for wall mounting.
3. Pressure Rating: 175 psig minimum.
4. Body Material: Corrosion-resistant metal.
5. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
6. Caps: Brass, lugged type, with gasket and chain.
7. Escutcheon Plate: Rectangular, brass, wall type.
8. Outlet: With pipe threads.
9. Body Style: Horizontal.
10. Number of Inlets: Two.
11. Outlet Location: Back or Bottom as shown on the drawings.
12. Escutcheon Plate Marking: Similar to " AUTO SPKR,," and if dual service, mark the 2nd service as well per University requirements.
13. Finish: Polished chrome plated.
14. Outlet Size: 4".
15. For the Evanston campus, provide a weatherproof, visual fire alarm signal device above the connection along with a weatherproof box/cabinet/panel for a future audible device.

2.8 SPRINKLER SPECIALTY PIPE FITTINGS

A. General Requirements for Dry-Pipe-System Fittings: UL listed for dry-pipe service.

B. Branch Outlet Fittings:

1. Standard: UL 213.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
4. Type: Mechanical-T and -cross fittings.
5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
7. Branch Outlets: Grooved, plain-end pipe, or threaded.

C. Flow Detection and Test Assemblies:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.

D. Zone/Floor Control Module:

1. UL listed, FM approved complete with flow switch, pressure gage, and ball valve.

F. Branch Line Testers:

1. Standard: UL 199.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Brass.
4. Size: Same as connected piping.
5. Inlet: Threaded.
6. Drain Outlet: Threaded and capped.
7. Branch Outlet: Threaded, for sprinkler.

G. Sprinkler Inspector's Test Fittings:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Cast- or ductile-iron housing with sight glass.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.

H. Adjustable Drop Nipples:

1. Standard: UL 1474.
2. Pressure Rating: 250 psig minimum.
3. Body Material: Steel pipe with EPDM O-ring seals.
4. Size: Same as connected piping.
5. Length: Adjustable.
6. Inlet and Outlet: Threaded.

I. Flexible, Sprinkler Hose Fittings:

1. Standard: UL 1474.
2. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
3. Pressure Rating: 175 psig minimum.
4. Size: Same as connected piping, for sprinkler.

J. Special Electrical Connection Requirements

1. For all devices/components requiring monitoring, etc, provide each with 2 sets of contacts, one for fire alarm system connection and one for Division 25 system connection.

2.9 SPRINKLERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Globe Fire Sprinkler Corporation.
 2. Reliable Automatic Sprinkler Co., Inc.
 3. Viking Corporation.
 4. Victaulic Company.
- B. General Requirements:
1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 2. Pressure Rating for Automatic Sprinklers: 175 psig minimum.
- C. Sprinkler Types:
1. Areas with suspended ceilings shall have dry type concealed pendent heads with 155 degree F sprinkler rating and 155 degree F cover plate rating. Cover to be color selected by Architect.
 2. All other areas without ceilings shall have standard brass dry type upright sprinklers with 165 degree F rating.
 3. Stairwells to have chrome plated dry type sidewall heads with 165 degree F rating.
- D. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
1. Sidewall Mounting: Chrome-plated steel one piece, flat.

2.10 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Water-Flow Indicators:
1. Standard: UL 346.
 2. Water-Flow Detector: Electrically supervised.
 3. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
 4. Type: Paddle operated.
 5. Pressure Rating: 250 psig.
 6. Design Installation: Horizontal or vertical.
- C. Valve Supervisory Switches:
1. Standard: UL 346.
 2. Type: Electrically supervised.
 3. Components: Single-pole, double-throw switch with normally closed contacts.

4. Design: Signals that controlled valve is in other than fully open position. Also, external tamper switches or external wired tamper switches are required.

D. Special Electrical Connection Requirements

1. For all devices/components requiring monitoring and/or supervision, provide each with 2 sets of contacts, one for fire alarm system connection and one for Division 25 system connection.

2.11 PRESSURE GAGES

- A. Standard: UL 393.
- B. Dial Size: 3-1/2- to 4-1/2-inch diameter.
- C. Pressure Gage Range: 0 to 300 psig.
- D. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face, as directed by the University/AHJ.
- E. Air System Piping Gage: Include retard feature and "AIR" or "AIR/WATER" label on dial face, as directed by the University/AHJ.

2.12 BACKFLOW PREVENTERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide a Conbraco RPDA reduced pressure detector backflow preventer assemblies. The assemblies shall consist of two independent tri-link check valves within a single housing, sleeve access port, four test cocks and two drip tight shut-off valves. Tri-link checks shall be removable and serviceable, without the use of special tools.
- B. The bypass assembly shall consist of a meter, which registers in either gallon or cubic measurement, a double check backflow assembly and required test cocks
- C. The housing shall be constructed of 304 Schedule 40 stainless steel pipe with grooved end connections. Tri-link checks shall have chloramine resistant silicone discs and in operation shall produce drip tight closure against reverse flow caused by backpressure or back-siphonage.
- D. UL/FM grooved gear operated butterfly valves with tamper switches.
- E. Refer to Division 22 for other requirements for when connection to domestic water mains or services. These required backflow preventers shall be furnished by the project plumbing contractor but installed by the Division 21 contractor. Refer to Section 22 2114.

PART 3 - EXECUTION

3.1 WATER-SUPPLY CONNECTIONS

- A. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements in Division 22 Section "Domestic Water Distribution System" for interior piping.
- B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-distribution piping.

3.2 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Piping Standard: Comply with requirements in NFPA 13 for installation of sprinkler piping.
- C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- D. Install unions adjacent to each valve in pipes 2" and smaller.
- E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having 2-1/2" and larger end connections.
- F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- G. Install sprinkler piping with drains for complete system drainage.
- H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- I. Install automatic (ball drip) drain valves to drain piping between fire-department connections and check valves. Drain to floor drain or to outside building.
- J. Install alarm devices in piping systems.
- K. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements in NFPA 13 for hanger materials.
- L. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than 1/4" and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- M. Drain dry-pipe sprinkler piping.

- N. Pressurize and check dry-pipe sprinkler system piping and air compressor(s).

3.3 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes 2" and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having 2-1/2" and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- I. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves and Switch Requirements:
 - 1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.

2. Dry-Pipe Valves: Install trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

- a. Install air compressor and compressed-air supply piping.

3. Valve supervisory switches shall be provided for each point where the water supply to the system or parts of the system can be shut off. Valves grouped at a common location can be combined into the same zone to a maximum of 5. In no case shall valves be concealed.

- E. For multi-story buildings, provide and install properly rated check valves at branches on each floor.

3.5 SPRINKLER INSTALLATION AND APPLICATION, AND SIGNAL MONITORING

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels unless the sprinklers can otherwise be aesthetically located, but off-center locations must be individually approved ahead of time by the University/Architect.

- B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

- C. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

- D. Quick response sprinklers are required in offices, classrooms, hallways, assembly areas, atriums, sleeping rooms, dining rooms, and most lab areas. Ordinary response sprinklers shall be used in storage areas, mechanical rooms, janitor closets, and areas where special coated sprinklers are required. Temperature ratings shall be the maximum expected ceiling temperatures.

- E. Trouble and alarm signals from the fire extinguishing systems shall be connected to the building's fire alarm system. Where not possible, alarm and trouble signals shall be transmitted to the University's central monitoring station.

3.6 FIRE-DEPARTMENT CONNECTION INSTALLATION

- A. Install wall-type, fire-department connections.

- B. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

3.7 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors.

- B. Escutcheons for New Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.

4. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish.
5. Bare Piping in Equipment Rooms: One piece, cast brass.
6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3.8 SLEEVE INSTALLATION

- A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
- B. Sleeves are not required for core-drilled holes.
- C. Permanent sleeves are not required for holes formed by removable PE sleeves.
- D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
- E. Install sleeves in new partitions, slabs, and walls as they are built.
- F. For interior wall penetrations, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants".
- G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants".
- H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals.
- I. Seal space outside of sleeves in concrete slabs and walls with grout.
- J. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe unless otherwise indicated.
- K. Install sleeve materials according to the following applications:
 1. Sleeves for Piping Passing through Concrete Floor Slabs: Galvanized-steel pipe.
 2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Galvanized-steel pipe.
 - a. Extend sleeves 2 inches above finished floor level.
 - b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements for flashing in Division 07 Section "Sheet Metal Flashing and Trim".
 3. Sleeves for Piping Passing through Gypsum-Board Partitions:
 - a. PVC-pipe sleeves for pipes smaller than 6 inch.
 - b. Galvanized-steel-sheet sleeves for pipes 6 inch and larger.
 - c. Exception: Sleeves are not required for water-supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.

4. Sleeves for Piping Passing through Exterior Concrete Walls:
 - a. Galvanized-steel-pipe sleeves for pipes smaller than 6 inch.
 - b. Cast-iron wall pipe sleeves for pipes 6 inch and larger.
 - c. Install sleeves that are large enough to provide 1 inch annular clear space between sleeve and pipe when sleeve seals are used.
5. Sleeves for Piping Passing through Interior Concrete Walls:
 - a. Galvanized-steel pipe sleeves for pipes smaller than 6 inch.
 - b. Galvanized-steel-sheet sleeves for pipes 6 inch and larger.

- L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestop materials and installations.

3.9 SLEEVE SEAL INSTALLATION

- A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.
- B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.10 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section covering identification for electrical systems.

3.11 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter, and per FM Global requirements.
 4. Energize circuits to electrical equipment and devices.
 5. Start and run air compressors.
 6. Coordinate with fire-alarm tests. Operate as required.
 7. Coordinate with fire-pump tests. Operate as required.
 8. Verify that equipment hose threads are same as local fire-department equipment.

- C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.12 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.

3.13 PIPING SCHEDULE

- A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
- B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- C. Dry-pipe sprinkler system, 2 inches and smaller, shall be one of the following:
 - 1. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
 - 2. Standard-weight Schedule 30 or thinwall, galvanized-steel pipe with plain ends; plain-end-pipe fittings; and twist-locked joints.
 - 3. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- D. Dry-pipe sprinkler system, 2-1/2 inches to 6 inches, shall be one of the following:
 - 1. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
 - 2. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

END OF SECTION 21 1314D

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SECTION 21 1314W - AUTOMATIC SPRINKLER SYSTEMS (WET PIPE SYSTEMS)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 21 0000, "General Fire Suppression Requirements."

1.2 SUMMARY

- A. Section Includes:
 - 1. Aboveground fire protection pipe, fittings, and specialties inside the building from 1'-0" above finished floor, 1'-0" inside the exterior wall, or connection provided in the domestic water line as shown on the drawings.
 - 2. Fire-protection valves.
 - 3. Fire-department connections.
 - 4. Sprinklers.
 - 5. Alarm devices.
 - 6. Pressure gages.
 - 7. Backflow preventers.

1.3 SYSTEM DESCRIPTIONS

- A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.
- B. Deluge and/or Pre-Action Systems: Provide as required for specific applications according to NFPA and FM Global requirements.

1.4 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a properly licensed and qualified Professional Engineer, using performance requirements and design criteria indicated. Professional Engineer shall seal (stamp) hydraulic calculations and sprinkler system drawings. Professional Engineer shall be registered in the State of Illinois.
 - 1. The Contractor shall perform a flow test in accordance with NFPA or obtain water design data from the Local Water Department if data is not shown on the drawings.

- C. Sprinkler system design shall be approved by the authorities having jurisdiction.
 - 1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
 - 2. Sprinkler Occupancy Hazard Classifications, densities, and head spacing shall be as indicated on the drawings.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.
- C. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Qualification Data: For qualified Installer and Professional Engineer.
- E. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- F. Welding certificates.
- G. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- H. Field quality-control reports.
- I. Operation and maintenance data.
- J. At closeout, Northwestern University Maintenance Requirement forms, refer to Division 01 for more information.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test with corrections to the flow obtained per NFPA 291 Part 4.12 System Correction.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a properly qualified and licensed Professional Engineer.
- B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. NFPA Standards and Other Requirements: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 - 1. NFPA 13, "Installation of Sprinkler Systems."
 - 2. NFPA 14, "Standpipe and Hose Systems."
 - 3. NFPA 70, "National Electrical Code."
 - 4. NFPA 72, "National Fire Alarm and Signaling Code."
 - 5. NFPA 291, "Fire Flow Testing and Marking of Hydrants."
 - 6. NFPA 1963, "Fire Hose Connections."
 - 7. Comply with the Illinois Building Code and Fire Code, and required references, the City of Chicago Building Code, Fire Prevention Code, and required references, and with all other requirements of the local Authority Having Jurisdiction (AHJ).
- E. Comply with FM Global requirements for general installation of systems, prevention and control of internal corrosion in automatic sprinkler systems, installations in any residential occupancies, for deluge, and pre-action valves and accessories, for cross connections, for pressure reducing valves for fire protection service, for system inspections, testing and maintenance, for pipe friction losses for hydraulics of fire protection systems, for fire protection pumps, for fixed water spray systems for fire protection, for water mist systems, for installation/maintenance of fire service mains, for standpipes and hose systems, and for fire protection water demand for non-storage sprinkled properties.
- F. WARRANTIES
 - 1. 5 years, see Section 21 0000.

PART 2 - PRODUCTS

- 2.1 All materials and components shall meet local jurisdiction, NFPA, and FM Global requirements.
- 2.2 PIPING MATERIALS
 - A. Comply with requirements in "Piping Schedule" Article at the end of this Section for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.
- 2.3 STEEL PIPE AND FITTINGS
 - A. Standard Weight, Black-Steel Pipe: ASTM A 53 Schedule 40. Pipe ends may be factory or field formed to match joining method.
 - B. Schedule 30, Black-Steel Pipe: ASTM A 135; ASTM A 795/A 795M,; or ASME B36.10M, wrought steel; with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.
 - C. Thinwall Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.

- D. Black Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
- E. Uncoated, Steel Couplings: ASTM A 865, threaded.
- F. Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- G. Malleable- or Ductile-Iron Unions: UL 860.
- H. Cast-Iron Flanges (must be approved by the University): ASME 16.1, Class 125.
- I. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- J. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
- K. Grooved-Joint, Steel-Pipe Appurtenances:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Corcoran Piping System Co.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
 - 2. Pressure Rating: 175 psig minimum.
 - 3. Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
 - 4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.4 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick.
 - 1. Full-face gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.5 LISTED FIRE-PROTECTION VALVES

- A. General Requirements:
 - 1. Valves shall be UL listed or FM approved, and meet FM Global requirements.
 - 2. Minimum Pressure Rating: 175 psig.
- B. Check Valves:
 - 1. Standard: UL 312.

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2. Pressure Rating: 250 psig minimum.
3. Type: Swing check.
4. Body Material: Cast iron.
5. End Connections: Flanged or grooved.

C. Bronze OS&Y Gate Valves:

1. Standard: UL 262.
2. Pressure Rating: 175 psig.
3. Body Material: Bronze.
4. End Connections: Threaded.

D. Iron OS&Y Gate Valves:

1. Standard: UL 262.
2. Pressure Rating: 250 psig minimum.
3. Body Material: Cast or ductile iron.
4. End Connections: Flanged or grooved.

E. Ball Valves 2" and smaller:

1. Standard UL 1091.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Bronze.
4. End Connections: Threaded.

F. Indicating-Type Butterfly Valves:

1. Standard: UL 1091.
2. Pressure Rating: 175 psig minimum.
3. Valve Type: Butterfly.
4. Body Material: Cast or ductile iron.
5. End Connections: Flanged, grooved, or wafer.
6. Valve Operation: Integral electrical, 115-V ac, prewired, single-circuit, supervisory switch indicating device.

2.6 TRIM AND DRAIN VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Minimum Pressure Rating: 175 psig.

2.7 SPECIALTY VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Minimum Pressure Rating: 175 psig.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.

5. End Connections: Flanged or grooved.

B. Riser Check Valves with Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Reliable Automatic Sprinkler Co., Inc.
 - b. Victaulic Company.
 - c. Viking Corporation.
2. Standard: UL 193.
3. Design: For vertical installation.
4. Trim Package: All necessary nipples and fittings, main drain valve, and gauges.

C. Automatic (Ball Drip) Drain Valves:

1. Standard: UL 1726.
2. Pressure Rating: 175 psig minimum.
3. Type: Automatic draining, ball check.
4. Size: NPS 3/4.
5. End Connections: Threaded.

2.8 FIRE-DEPARTMENT CONNECTIONS

A. Flush-Type, Fire-Department Connection:

1. Standard: UL 405.
2. Type: Flush, for wall mounting.
3. Pressure Rating: 175 psig minimum.
4. Body Material: Corrosion-resistant metal.
5. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
6. Caps: Brass, lugged type, with gasket and chain.
7. Escutcheon Plate: Rectangular, brass, wall type.
8. Outlet: With pipe threads.
9. Body Style: Horizontal.
10. Number of Inlets: Two.
11. Outlet Location: Back.
12. Escutcheon Plate Marking: Similar to " AUTO SPKR", and if dual service, mark the 2nd service as well per University requirements.
13. Finish: Polished chrome plated.
14. Outlet Size: 4".
15. For the Evanston campus, provide a weatherproof, visual fire alarm signal device above the connection along with a weatherproof box/cabinet/panel for a future audible device.

2.9 SPRINKLER SPECIALTY PIPE FITTINGS

A. Branch Outlet Fittings:

1. Standard: UL 213.
2. Pressure Rating: 175 psig minimum.

3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
4. Type: Mechanical-T and -cross fittings.
5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
7. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.

C. Zone/Floor Control Module:

1. UL listed, FM approved complete with flow switch, pressure gage, and ball valve.

D. Branch Line Testers:

1. Standard: UL 199.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Brass.
4. Size: Same as connected piping.
5. Inlet: Threaded.
6. Drain Outlet: Threaded and capped.
7. Branch Outlet: Threaded, for sprinkler.

E. Sprinkler Inspector's Test Fittings:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Cast- or ductile-iron housing with sight glass.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.

F. Adjustable Drop Nipples:

1. Standard: UL 1474.
2. Pressure Rating: 250 psig minimum.
3. Body Material: Steel pipe with EPDM-rubber O-ring seals.
4. Size: Same as connected piping.
5. Length: Adjustable.
6. Inlet and Outlet: Threaded.

G. Braided Flexible, Sprinkler Hose Fittings:

1. Standard: UL 1474.
2. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.

3. Pressure Rating: 175 psig minimum.
4. FM approved.
5. Size: Same as connected piping, for sprinkler.

2.10 SPRINKLERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Globe Fire Sprinkler Corporation.
2. Reliable Automatic Sprinkler Co., Inc.
3. Viking Corporation.
4. Victaulic Company.

- B. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating for Automatic Sprinklers: 175 psig minimum.
3. Sprinklers shall be used in accordance with their listed coverage limitations.
4. Sprinkler temperature classification shall be ordinary **[intermediate] [as indicated]**.
5. Sprinklers in high heat areas including attic spaces or in close proximity to unit heaters shall have temperature classification in accordance with NFPA 13.

- C. Sprinkler Types:

1. Concealed Sprinkler: Concealed sprinkler shall be chrome-plated quick-response type and shall have a nominal 1/2 inch or 17/32 inch orifice. Cover to be color selected by Architect.
2. Recessed Sprinkler: Recessed sprinkler shall be chrome-plated quick-response type and shall have a nominal 1/2 inch or 17/32 inch orifice.
3. Upright Sprinkler: Upright sprinkler shall be chrome-plated quick-response type and shall have a nominal 1/2 inch or 17/32 inch orifice.
4. Sidewall Sprinkler: Sidewall sprinkler shall have a nominal 1/2 inch orifice. Sidewall sprinkler shall have a polished chrome finish. Sidewall sprinkler shall be the quick-response type.
5. Intermediate Level Rack Sprinkler: Intermediate level rack sprinkler shall be of the upright or pendent type with nominal 13 mm 1/2 inch orifice and minimum "K" factor of 5.5. The sprinkler shall be equipped with a deflector plate to shield the fusible element from water discharged above it.

- D. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Sidewall Mounting: Chrome-plated steel, one piece, flat.

- E. Sprinkler Guards

1. Guards shall be a steel wire cage designed to encase the sprinkler and protect it from mechanical damage. Guards shall be provided on sprinklers in sports activity areas, and as otherwise noted on drawings.

2.11 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Water-Flow Indicators:
 - 1. Standard: UL 346.
 - 2. Water-Flow Detector: Electrically supervised.
 - 3. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
 - 4. Type: Paddle operated.
 - 5. Pressure Rating: 250 psig.
 - 6. Design Installation: Horizontal or vertical.
- C. Valve Supervisory Switches:
 - 1. Standard: UL 346.
 - 2. Type: Electrically supervised.
 - 3. Components: Single-pole, double-throw switch with normally closed contacts.
 - 4. Design: Signals that controlled valve is in other than fully open position. Also, external tamper switches or external wired tamper switches are required.

2.12 PRESSURE GAGES

- A. Standard: UL 393.
- B. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.
- C. Pressure Gage Range: 0 to 300 psig (0 to 2070 kPa).
- D. Water System Piping Gage: Include "WATER" label on dial face, as directed by the University/AHJ.

2.13 BACKFLOW PREVENTERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide a Conbraco RPDA reduced pressure detector assembly backflow preventer. The assembly shall consist of two independent tri-link check valves within a single housing, sleeve access port, four test cocks and two drip tight shut-off valves. Tri-link checks shall be removable and serviceable, without the use of special tools.
- B. The bypass assembly shall consist of a meter, which registers in either gallon or cubic measurement, a double check backflow assembly and required test cocks
- C. The housing shall be constructed of 304 Schedule 40 stainless steel pipe with grooved end connections. Tri-link checks shall have chloramine resistant silicone discs and in operation shall produce drip tight closure against reverse flow caused by backpressure or back-siphonage.
- D. UL/FM grooved gear operated butterfly valves with tamper switches.

- E. Refer to Division 22 for other requirements for when connection to domestic water mains or services. These required backflow preventers shall be furnished by the project plumbing contractor but installed by the Division 21 contractor. Refer to Section 22 2114.

2.14 SPECIAL COMPONENT ELECTRICAL CONTACT REQUIREMENTS

- A. All devices/components required to be monitored electrically for flow, tamper, etc, shall have two sets of contacts, one for the fire alarm system connection and one for the Division 25 system connection.

PART 3 - EXECUTION

3.1 WATER-SUPPLY CONNECTIONS

- A. If applicable, connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Division 22 Section "Domestic Water Distribution System."
- B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-distribution piping.

3.2 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
- C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- D. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- G. Install sprinkler piping with drains for complete system drainage.
- H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- I. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

- J. Install alarm devices in piping systems.
- K. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- L. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- M. Fill sprinkler system piping with water.
- N. For multi-story buildings, refer to Section 21 0000 for floor branch check valve requirements.

3.3 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- D. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- F. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- G. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- H. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- I. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install backflow preventers at connection to potable-water-supply source.
- D. Specialty Valves and Switch Requirements:
 - 1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
 - 2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.
 - 3. Valve supervisory switches shall be provided for each point where the water supply to the system or parts of the system can be shut off. Valves grouped at a common location can be combined into the same zone to a maximum of 5. In no case shall valves be concealed.
- E. All devices/components required to be monitored electrically for flow, tamper, etc, shall have two sets of contacts, one for the fire alarm system connection and one for the Division 25 system connection.

3.5 SPRINKLER INSTALLATION AND APPLICATION

- A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels or where indicated on Architectural Reflected Ceiling Plans, unless the sprinklers can be otherwise be aesthetically located, but off-center locations must be approved ahead of time individually by the University/Architect.
- B. Quick response sprinklers are required in offices, classrooms, hallways, assembly areas, atriums, sleeping rooms, dining rooms, and most lab areas. Ordinary response sprinklers shall be used in storage areas, mechanical rooms, janitor closets, and areas where special coated sprinklers are required. Temperature ratings shall be the maximum expected ceiling temperatures.
- C. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

3.6 FIRE-DEPARTMENT CONNECTION INSTALLATION

- A. Install wall-type, fire-department connection.
- B. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

3.7 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors.
- B. Escutcheons for New Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
4. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish.
5. Bare Piping in Equipment Rooms: One piece, cast brass.
6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3.8 SLEEVE INSTALLATION

- A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
- B. Sleeves are not required for core-drilled holes.
- C. Permanent sleeves are not required for holes formed by removable PE sleeves.
- D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
- E. Install sleeves in new partitions, slabs, and walls as they are built.
- F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."
- G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."
- H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals.
- I. Seal space outside of sleeves in concrete slabs and walls with grout.
- J. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.
- K. Install sleeve materials according to the following applications:
 1. Sleeves for Piping Passing through Concrete Floor Slabs: Galvanized-steel pipe.
 2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Galvanized-steel pipe.
 - a. Extend sleeves 2 inches above finished floor level.
 - b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements for flashing in Division 07 Section "Sheet Metal Flashing and Trim."
 3. Sleeves for Piping Passing through Gypsum-Board Partitions:

- a. Galvanized-steel-sheet sleeves for pipes NPS 6 (DN 150) and larger.
- 4. Sleeves for Piping Passing through Exterior Concrete Walls:
 - a. Galvanized-steel-pipe sleeves for pipes smaller than NPS 6.
 - b. Cast-iron wall-pipe sleeves for pipes NPS 6 and larger.
 - c. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
- 5. Sleeves for Piping Passing through Interior Concrete Walls:
 - a. Galvanized-steel-pipe sleeves for pipes smaller than NPS 6.
 - b. Galvanized-steel-sheet sleeves for pipes NPS 6 and larger.
- L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestop materials and installations in Division 07 Section "Penetration Firestopping."

3.9 SLEEVE SEAL INSTALLATION

- A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.
- B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.10 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section covering identification for electrical systems.

3.11 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter, and to FM global requirements.
 - 4. Energize circuits to electrical equipment and devices.
 - 5. Coordinate with fire-alarm tests. Operate as required.
 - 6. Verify that equipment hose threads are same as local fire-department equipment.

- C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.12 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.

3.13 PIPING SCHEDULE

- A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
- B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- C. Wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:
 - 1. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 - 2. Standard-weight or Schedule 30, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 6, shall be one of the following:
 - 1. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 - 2. Standard-weight or Schedule 30, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 3. Thinwall black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.14 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
 - 1. Rooms without Ceilings: Upright sprinklers.
 - 2. Rooms with Suspended Ceilings: [**Recessed sprinklers**] [**Concealed sprinklers**]
 - 3. Wall Mounting: Sidewall sprinklers.
 - 4. Spaces Subject to Freezing: [**Pendent, dry sprinklers**] [**Sidewall, dry sprinklers**]
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
 - 1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
 - 2. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.

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3. **[Upright]** and **[Sidewall]** Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 21 1314W

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SECTION 21 2400CA - CLEAN AGENT CHEMICAL SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 21 0000 – General Fire Suppression Requirements.

1.2 APPLICABLE STANDARDS AND PUBLICATIONS

- A. The design, installation, testing and maintenance of the Clean Agent Extinguishing System shall be in accordance with the applicable requirements set forth in the latest edition of the following codes, standards, and third party approval agencies:
 - 1. Illinois Building Code, Fire Code, and required references
 - 2. City of Chicago Building Code, Fire Prevention Code, and required references.
 - 3. Requirements of the local Authority Having Jurisdiction (AHJ)
 - 4. NFPA 2001: Standard on Clean Agent Fire Extinguishing Systems
 - 5. NFPA 70: National Electrical Code
 - 6. NFPA 72: National Fire Alarm and Signaling Code
 - 7. NFPA 75: Standard for the Protection of Electronic Computer/Data Processing Equipment
 - 8. FM Global
 - 9. Underwriters Laboratories (UL)

1.3 SUMMARY

- A. Section Includes:
 - 1. Piping and piping specialties.
 - 2. Extinguishing-agent containers.
 - 3. Extinguishing agent.
 - 4. Detection and alarm devices.
 - 5. Releasing control panel.
 - 6. Accessories.
 - 7. Connection devices for and wiring between system components.
 - 8. Connection devices for power and integration into building's fire-alarm system.
- B. Section Excludes:
 - 1. Power supply (120/208 VAC) to system control panel.
 - 2. Interface (conduit and wiring) to HVAC units, dampers, electric power supplies, relays, or shunt-trip breakers.
 - 3. Interface (conduit and wiring) to local/remote fire alarm system
 - 4. Connection to listed central station fire alarm system.

5. Connection to University SCADA system covered by Division 25.
6. Room sealing, other than penetrations made by the suppression system contractor during system installation. Suppression system contractor shall coordinate room sealing requirements with project's General Contractor and all sub-contractors.

1.4 DEFINITIONS

- A. AHJ: Authority Having Jurisdiction.
- B. ATS: Acceptance Testing Specifications.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

B. [LEED Submittals:

- 1. Product Data for Credit EA 4: Documentation indicating that clean agents comply.]**

- C. Shop Drawings:

1. Prepared by persons with the following qualifications:
 - a. Properly licensed and qualified professional engineer licensed in the State of Illinois,
 - b. Trained and certified by the manufacturer of the Clean Agent Suppression system.
2. Comply with recommendations in the "Working Plans" Section of the "System Design" Chapter in NFPA 2001.
3. Comply with the recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
4. Include plans, elevations, sections, details, and attachments to other work.
5. Include design calculations: Enclosure volume, agent quantity, backup battery, voltage drop, detector spacing, etc.
6. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
7. Include plans to indicate mounting location of field devices, including size and routing of cable and conduits.
8. Submittals shall be signed and sealed by a qualified Professional Engineer registered in the State of Illinois prior to submitting them to the Authority Having Jurisdiction.
9. Submittals shall be approved by the Authority Having Jurisdiction prior to submitting them to Architect.

- D. Delegated-Design Submittal: For clean agent systems indicated to comply with performance requirements and design criteria, including analysis data signed by the professional engineer responsible for their preparation.

1. Indicate compliance with performance requirements and design criteria, including analysis data.
2. Include design calculations for selecting the spacing and sensitivity of detection devices, complying with NFPA 72 and FM Global requirements.

3. Include design calculations for weight, volume, and concentration of extinguishing agent required for each hazard area.
4. Include design calculations for enclosure pressure relief/venting as required to avoid structural damage to the hazard enclosure, equipment, or building.
5. Indicate the Following on Reflected Ceiling Plans:
 - a. Ceiling penetrations and ceiling-mounted items.
 - b. Extinguishing-agent containers if mounted above floor, piping and discharge nozzles, detectors, and accessories.
 - c. Method of attaching hangers to building structure.
 - d. Other ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, and access panels.
6. Indicate the Following on Occupied Work Area Plans:
 - a. Controls and alarms.
 - b. Extinguishing-agent containers, piping and discharge nozzles if mounted in space, detectors, and accessories.
 - c. Equipment and furnishings.
7. Indicate the Following on Access Floor Space Plans:
 - a. Extinguishing-agent containers, piping and discharge nozzles, detectors, and accessories.
 - b. Method of supporting piping.
8. Indicate the Following on Ceiling Plans:
 - a. Extinguishing-agent containers, piping and discharge nozzles, detectors, and accessories.
 - b. Method of supporting piping.
 - c. Other equipment located in the ceiling space that is being protected including sprinkler piping, HVAC equipment, raceways, or conduit.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 1. Domestic water piping.
 2. Lighting fixtures.
 3. HVAC Air outlets and inlets.
- B. Permit Approved Drawings: Working plans, prepared according to NFPA 2001, that have been approved by Authorities Having Jurisdiction. Include design calculations.
- C. Field quality-control reports.
- D. Installer Qualifications:
 1. Authorized distributor of the system manufacturer. Shall maintain an inventory of replacement parts.

2. Trained by the system manufacturer to design, install, test, and maintain the clean agent extinguishing system.
3. Provide proof of emergency service available on a twenty-four hour, seven-days-a-week basis.
4. Maintain or have access to a recharging station capable of recharging the largest suppression system within 72 hours after a discharge.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For special agent system to include in emergency, operation, and maintenance manuals.
- B. Deliver copies to Authorities Having Jurisdiction and include the following:
 1. Comply with the "Records" Section of the "Inspections, Testing and Maintenance" Chapter of NFPA 72.
 2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 3. Record copy of site-specific software.
 4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
 - a. Frequency of testing of installed components.
 - b. Frequency of inspection of installed components.
 - c. Requirements and recommendations related to results of maintenance.
 - d. Manufacturer's user training manuals.
 5. Manufacturer's required maintenance related to system warranty requirements.
 6. Abbreviated operating instructions for mounting at the control panel.
 7. Copy of NFPA 25.
- C. As-built Drawings: Indicate actual installation configuration at time of project completion including all equipment locations, pipe routing, conduit routing, room configurations, etc.
- D. Northwestern University Maintenance Requirement Forms, refer to Division 01 for more information.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.
 1. Detection Devices: Area smoke detectors, quantity as required, minimum two (2).

1.9 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. Comply with FM Global requirements for general installation of clean agent systems, and for system inspections, testing and maintenance.
- C. Additional FM Global Compliance: Provide components that are FM Global Approved and that are listed in FM Global's "Approval Guide."
- D. UL Compliance: Provide equipment listed in UL's "Fire Protection Equipment Directory."
- E. All devices, components, and equipment shall be new, standard products of the manufacturer's latest design and suitable to perform the functions intended. The name of the manufacturer, part number, and serial number shall appear on all major components.
- F. Locks for all cabinets shall be keyed alike.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide a Fike; FM-200 system, or an equal system by one of the following manufacturers:
 - 1. Chemetron Fire Systems; a UTC Fire & Security company.
 - 2. Fenwal Protection Systems.
- B. Description: Clean-agent fire-extinguishing system shall be an engineered system for total flooding of the hazard area.
- C. Design: Design clean-agent fire-extinguishing system and obtain approval from Authorities Having Jurisdiction. Design system for Class A, B, and C fires as appropriate for areas being protected, and include safety factor. Use clean agent indicated and in concentration suitable for normally occupied areas.
- D. Performance Requirements: (FM-200 per NFPA 2001).
 - 1. Minimum design concentration: As calculated, by volume in all areas and/or protected spaces at the minimum anticipated temperature within the protected area.
 - 2. The system design shall not exceed a maximum exposure limit concentration level per NFPA 2001, unless provisions for room evacuation before agent release are provided. All personnel should be able to leave the protected space prior to the discharge or at least within 5 minutes of the commencement of discharge.
- E. Verified Detection: Devices located in single zone. Sound alarm on activating single-detection device, and discharge extinguishing agent on actuating second-detection device.

2.2 SYSTEM OPERATING SEQUENCE

- A. Verified Detection:
 - 1. Actuating First Detector (Pre-Alarm):
 - a. Visual and audible indication on local control panel.

- b. Energize audible and visual alarms inside the protected hazard area (unique pattern).
 - c. Transfer relays to shut HVAC duct dampers serving protected area and send "pre-alarm" signal to main fire-alarm system panel.
 2. Actuating Second Detector (Pre-discharge):
 - a. Visual and audible indication on local control panel.
 - b. Energize audible and visual alarms inside the protected hazard area (unique pattern).
 - c. Transfer relay to shut down power to protected area man-door security lock, that then allows man-door to be opened from Corridor side (bypassing security system).
 - d. Transfer relays to shut down recirculating air-conditioning units serving protected area.
 - e. Start time delay for extinguishing-agent discharge for 30 seconds.
 - f. Initiate system abort sequence, if abort switch is pressed and held in "abort" position. Release of hand pressure on the abort switch will cause agent discharge if the discharge time delay has expired.
 3. Extinguishing-agent discharge (Release Alarm): Pre-discharge time delay expires or manual release switch is operated.
 - a. Visual and audible indication on local control panel.
 - b. Energize audible and visual alarms inside and outside the protected area (unique pattern).
 - c. Transfer relay to send "Extinguishing Agent Release" to main fire alarm system panel.
 - d. Release clean agent suppression system agent.
- B. Supervisory signal initiation shall be by the following device:
 1. Either clean agent container low pressure switch.
- C. Trouble signal initiation shall be by one or more of the following devices and actions:
 1. Open circuits, shorts, and grounds in designated circuits.
 2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 3. Loss of primary power at fire-alarm control unit.
 4. Ground or a single break in fire-alarm control unit internal circuits.
 5. Abnormal AC voltage at fire-alarm control unit.
 6. Break in standby battery circuitry.
 7. Failure of battery charging.
 8. Abnormal position of any switch at fire-alarm control unit or annunciator.
- D. System Supervisory and Trouble Signal Actions:
 1. Visual and audible indication on control panel.
 2. Transfer relays to send signal to fire-alarm system.
- E. Operating manual release switches will cause the immediate discharge of the extinguishing agent, overriding the system's discharge time delay and abort functions. Panel operation shall duplicate the extinguishing-agent discharge sequence described in the previous paragraphs.

1. Electric manual release switches shall be located at each hazard exit.

F. Operating abort switches will delay extinguishing-agent discharge while being activated. Release of hand pressure on the switch will cause agent discharge if the discharge time delay has expired.

2.3 PIPING MATERIALS

A. Piping, Valves, and Discharge Nozzles: Comply with types and standards listed in NFPA 2001.

B. Plain end couplings are not allowed on any piping systems.

C. No welding allowed.

2.4 VALVES

A. General Valve Requirements:

1. UL listed and FM Global approved for use in fire-protection systems.
2. Compatible with type of clean agent used.
3. Automatic excessive pressure relief provision.
4. Low pressure gauge.

B. Container Valves: With fast acting rupture disc with solenoid actuator, capable of immediate and total agent discharge and suitable for intended flow capacity.

C. Valves in Sections of Closed Piping and Manifolds: Fabricate to prevent entrapment of liquid, or install valve and separate pressure relief device.

D. Valves in Manifolds: Check valve; installed to prevent loss of extinguishing agent when container is removed from manifold.

2.5 EXTINGUISHING AGENT CONTAINERS

A. Description: High strength alloy steel tanks complying with ASME Boiler and Pressure Vessel Code: Section VIII, for unfired pressure vessels. Include minimum working-pressure rating that matches system charging pressure, valve, pressure switch, and pressure gage.

1. Finish: RED, enamel or epoxy paint.
2. Manifold: Fabricate with valves, pressure switches, and connections for multiple storage containers, as indicated.
3. Storage-Tank Brackets: Factory- or field-fabricated retaining brackets consisting of steel straps and channels; suitable for container support, maintenance, and tank refilling or replacement.

B. Location: Located within hazard area, or as near as possible to reduce the required amount of pipe and fittings.

2.6 FIRE-EXTINGUISHING CLEAN AGENT

A. FM-200 Clean Agent: Heptafluoropropane.

1. Basis-of-Design Product: Subject to compliance with requirements, provide FM-200 product by one of the following:
 - a. DuPont.
 - b. Great Lakes Chemical Corporation; a Chemtura company.

2.7 DISCHARGE NOZZLES

- A. Equipment manufacturer's standard one-piece brass or aluminum alloy of type, size, discharge pattern, and capacity required for application.

2.8 CONTROL PANELS

- A. Description: FM Global approved and NRTL listed, including equipment and features required for testing, supervising, and operating fire-extinguishing system. Listed and approved for releasing service, and suitable for deluge/pre-action sprinkler service.

1. Subject to compliance with requirements, provide Fike®; SHP-PRO® or comparable product by one of the following:
 - a. Chemetron Fire Systems; a UTC Fire & Security company.
 - b. Fenwal Protection Systems.

- B. Power Requirements: 120-V ac; with electrical contacts for connection to system components, fire-alarm system, and Division 25 SCADA system, and transformer or rectifier as needed to produce power at voltage required for initiating devices, notification appliances, trouble signals, supervisory signals, digital alarm communicator transmitter, and auxiliary power.

1. Alarm current draw of the entire clean agent suppression system shall not exceed 80 percent of the control panel's power supply rating.

- C. Enclosure: NEMA ICS 6, Type 1, steel cabinet.

1. Mounting: Surface.
2. Finish: Red baked on enamel finish

- D. Supervised Circuits: Wired NFPA 72, Class B

1. Two detection circuits; capable of sequential detector release actuation method.
2. Three initiating device circuits; capable of monitoring contact closure devices.
3. Minimum of three notification appliance circuits.
4. Agent release circuit capable of actuating suppression system.
5. Auxiliary power circuit (resettable/non-resettable) for field devices.
6. Minimum of three Form-C relay contacts for auxiliary control functions.
7. Additional Form-C relay contacts with addition of supplemental relay cards as required.

- E. Control-Panel Features:

1. Microprocessor controlled.

2. LED indicators to provide positive indication of system status.
3. Diagnostic LED indicator to display system and trouble events.
4. Configurable via dip-switches.
5. Automatic switchover to standby power at loss of primary power.
6. Storage container, low-pressure indicator.
7. Service disconnect to interrupt system operation for maintenance with visual status indication on the panel.
8. Silence and reset switch.
9. 120 VAC power input.
10. Five optional abort types.

F. Standby Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed lead calcium, sized to operate system for 24 hours and alarm for minimum of 15 minutes.

G. Optional Cards: Cards mount directly to and receive their operational power from the Fike SHP PRO® control board (or comparable card by Chemetron or Fenwall).

1. Relay Module: Provides four additional Form-C relay contacts for auxiliary control functions.

2.9 SYSTEM SMOKE DETECTORS

A. General Requirements:

1. Comply with NFPA 2001, NFPA 72, and UL 268.
2. 24-V dc, nominal.
3. Two-wire type.
4. Self-restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
5. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
6. UL Listed.

B. Photoelectric Detectors: LED light source and silicon photodiode receiving element.

C. Base Mounting: Detector shall be mounted on a twist-lock, fixed base.

1. Select according to operational characteristics: Verified detection release.
2. Base provides terminals for connection to control unit.

D. Signals to the Central Fire Alarm Control Panel: Any type of local system Alarm, Trouble, or Supervisory event is reported to the central fire alarm control panel as a composite signal for each event type.

2.10 SWITCHES

A. General Description: Surface FM Global approved and NRTL listed, low voltage, includes contacts for connection to control panel.

- B. Manual Release Switch: Unit can manually discharge extinguishing agent with operating device that remains engaged until unlocked.
 - 1. Stainless steel faceplate.
 - 2. Dual-action requiring two distinct operations to initiate suppression system release.
 - 3. Red plastic release button, keyed reset.
 - 4. "MANUAL RELEASE" caption.

- C. Abort Switch: Unit can manually prevent the release of the suppression system while pressed.
 - 1. Stainless steel faceplate.
 - 2. Red plastic abort button, momentary contact (dead-man type).
 - 3. Available with key-operated switch.
 - 4. "SYSTEM ABORT" caption.

- D. Low-Agent Pressure Switches: Installed on extinguishing agent container; pneumatic operation.

- E. Suppression Disconnect Switches: Unit enables releasing circuit (i.e., clean agent) to be disconnected from the control panel.
 - 1. Stainless steel faceplate.
 - 2. Key operated selector switch (armed/disarmed).
 - 3. LEDs to provide indication of switch status (armed/disarmed).
 - 4. "SUPPRESSION DISCONNECT" caption.

2.11 ALARM DEVICES

- A. General Requirements: Listed and labeled by an NRTL and/or FM Global approved, low voltage, and surface mounting.

- B. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly. Connected to notification appliance signal circuits, equipped for mounting as indicated and with screw terminals for system connections.

- C. Horns, comply with UL 464: Electric-vibrating-polarized type, 24-V dc. Horns shall produce a sound-pressure level of 90 dBA minimum, measured 10 feet (3 m) from horn.

- D. Visible Notification Appliances, comply with UL 1971: Xenon strobe lights with translucent lens, with "FIRE" or similar caption.
 - 1. Rated Light Output:
 - a. Indicated on drawings.
 - b. 15/30/75/110 cd, selectable in the field.

 - 2. Mounting: Indicated on Drawings.
 - 3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
 - 4. Flashing shall be in a temporal pattern, synchronized with other units.
 - 5. Strobe Leads: Factory connected to screw terminals.
 - 6. Mounting Faceplate: Factory finish, red.

2.12 INFORMATIONAL SIGNAGE

- A. Provide informational signs as required to comply with NFPA 2001 for the specific agent.

2.13 SPECIAL CONNECTIONS

- A. For any devices/components that require monitoring or supervision, provide with at least two sets of contacts, one for connection to the fire alarm system and one for connection to the SCADA system (covered under Division 25)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with hazard-area leakage requirements, installation tolerances, and other conditions affecting work performance.
 - 1. The general contractor shall be responsible for sealing and securing the protected enclosure against agent loss and/or leakage during the required agent "hold" period.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PIPING APPLICATIONS

- A. Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.
- B. Comply with types and standards listed in NFPA 2001.

3.3 PIPING APPLICATIONS

- A. Comply with types and standards listed in NFPA 2001.

3.4 CLEAN-AGENT PIPING INSTALLATION

- A. Install clean-agent extinguishing piping and other components level and plumb, according to manufacturers' written instructions.
- B. Each pipe section shall be cleaned internally after preparation and before assembly by means of swabbing, using a suitable nonflammable cleaner. Pipe network shall be free of particulate matter and oil residue before installing nozzles or discharge devices.
- C. Install extinguishing-agent containers anchored to substrate.
- D. All pipe threads shall be sealed with Teflon tape pipe sealant applied to the male threads only.
- E. Install pipe and fittings, valves, and discharge nozzles according to requirements listed in NFPA 2001.

1. Install valves designed to prevent entrapment of liquid, or install pressure relief devices in valved sections of piping systems.
2. Support piping using supports and methods according to NFPA 13.

3.5 DETECTION, ACTUATION, ALARM, AND CONTROL SYSTEMS INSTALLATION

- A. Install control panels, detection system components, alarms, and accessories, complying with requirements of NFPA 72 and NFPA 2001, Section "Detection, Actuation, and Control Systems," as required for supervised system application.
- B. Smoke Detector Spacing:
 1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke detector spacing.
 2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat detector spacing.
 3. Smoke ceiling spacing shall not exceed 30 feet (9 m).
 4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.
 5. HVAC: Locate detectors not closer than 3 feet (1 m) from air-supply diffuser or return-air opening.
 6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture.
- C. Audible Alarm-Indicating Devices: Wall mounted with tops above the finished floor not less than 90 inches (2.29 m), and below the ceiling not less than 6 in. (150 mm). Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
- D. Visible Alarm-Indicating Devices: Wall mounted with entire lens not less than 80 in. (2.03 m) and not greater than 96 in. (2.44 m) above the finished floor. Where ceiling height does not permit mounting at minimum height, mount within 6 inches (150 mm) of the ceiling.
- E. Combination Audible-Visual Devices: Where combination audible and visual devices are used, mount devices according to Visual Alarm-Initiating Device requirements.
- F. Control Unit: Surface mount, with top of cabinet not more than 72 inches (1830 mm) above the finished floor.
- G. Annunciator: Install with top of panel not more than 72 inches (1830 mm) above the finished floor.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance.
- C. Connect electrical devices to control panel, to building's fire-alarm system, and to building SCADA system (covered under Division 25).

3.7 IDENTIFICATION

- A. Identify system components, equipment, wiring, cabling, and terminals. Comply with requirements for identification specified in applicable Division 26 Section covering identification for electrical systems.
- B. Identify piping, extinguishing-agent containers, other equipment, and panels according to NFPA 2001.
- C. Install signs at entry doors for protected areas to warn occupants that they are entering a room protected with a clean-agent fire-extinguishing system.
- D. Install signs at entry doors to advise persons outside the room the meaning of the horn(s), bell(s), and strobe light(s) outside the protected space.
- E. Install framed operating instructions in a location visible from control unit.

3.8 SYSTEM WIRING

- A. Wiring shall be installed by qualified individuals, in a neat and workmanlike manner in accordance with the National Electrical Code (NEC), Article 725 and 760, except as otherwise permitted for limited energy circuits as described in NFPA 72. Installation shall meet all local, state, province and/or country codes.
- B. All wiring shall be installed in electrical metallic tubing (EMT) or conduit, and must be kept separate from all other building wiring. Runs of conduit shall be straight, neatly arranged, properly supported and installed parallel and perpendicular to walls and partitions.
- C. Conductors shall be sized according to the design documents and color coded to allow easy circuit identification.
- D. All wires shall be tagged at all junction boxes.
- E. All wires shall be tested for the presence of opens, shorts and grounds prior to connection to control panel. Final wire terminations to control panel shall be made under the direct supervision of a factory trained representative.
- F. All system components shall be securely supported independent of the wiring.
- G. Ground control panel and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to control panel.

3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
 - D. Submit test plan for review and approval by the owner or owner's designated representative prior to performing tests.
 - E. Detection, Actuation, Alarm, and Control Systems Tests:
 1. Visual Inspection: Conduct the visual inspection prior to testing.
 - a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter, and as per FM Global requirements.
 - b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 2. Operational Test: After electrical circuitry has been energized, apply power to control panel and confirm proper unit operation. Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing, and Maintenance" Chapter in NFPA 72, and comply with FM global requirements.
 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - F. Clean-Agent Fire Extinguishing Systems Test:
 1. Flow Test: Using nitrogen or other inert gas, perform a flow test on the piping network to verify that flow is continuous and unobstructed through piping and nozzles.
 2. Pressure/Leak Test: test the piping in a closed circuit per manufacturer instructions.
 3. Room Pressurization Test: After all construction work is complete, conduct a room pressurization test in accordance with NFPA 2001 in each clean agent suppression system hazard area. Test shall confirm enclosures ability to retain the agent concentration level for the required hold time. If the test fails, the suppression system contractor shall coordinate room sealing with the general contractor. Additional tests shall be conducted until successful test results are achieved. Include final test results in project 'Closeout Submittals'.
 - G. System will be considered defective if it does not pass tests and inspections.
 - H. Prepare test and inspection reports: Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
- 3.10 DEMONSTRATION / TRAINING
- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the clean-agent fire-extinguishing systems.

- B. Training session shall include system control panel operation, manual and abort functions, trouble procedures, auxiliary functions, and emergency procedures. Allow a minimum of 4 hours for training.
- C. All training shall be video-taped by the Fire Protection contractor. Two copies shall be turned over to the Owner's maintenance staff.
- D. Prior to final acceptance, provide four copies of a complete operation and maintenance manual to the Architect. The manual shall include the following:
 - 1. All aspects of system operation and maintenance detailed, including piping isometrics, wiring diagrams of all circuits, a written description of system design and sequence of operation.
 - 2. Drawing(s) illustrating control logic.
 - 3. Equipment used in the fire suppression system.
 - 4. Checklists and procedures for emergency situations.
 - 5. Troubleshooting techniques.
 - 6. Maintenance operations and procedures.

3.11 SERVICE CONTRACT DURING WARRANTY PERIOD

- A. Suppression system installing contractor shall provide two (2) inspections of the systems installed under this contract, during the warranty period. The first inspection shall be at the six month interval, and the second shall be at the twelve month interval after system acceptance.
- B. Inspections shall be conducted in accordance with the equipment manufacturer's guidelines and the recommendations of NFPA 72 and NFPA 2001. Use forms provided in NFPA 72 for initial tests and inspections.
- C. Prepare and submit test and inspection reports.

3.12 WARRANTY

- A. Clean Agent System manufacturer shall guarantee all components furnished under this contract against defects in design, materials, and workmanship for no less than five (5) years from the date of handover to Owner at beneficial occupancy.

END OF SECTION 21 2400CA

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FOR: _____
ISSUED: 03/29/2017

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SECTION 21 2400WC – CHEMICAL SUPPRESSION SYSTEMS (WET CHEMICAL)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

- 1. Tanks, mounting bracketry/hardware, distribution piping and discharge nozzles, automatic detection components, actuation components, control panel, gages, and wet chemical agent for system.
- 2. Other necessary components required for a complete system.

B. Related Requirements:

- 1. Section 21 0000 "General Fire Suppression Requirements."
- 2. Applicable Division 11 Section(s) covering kitchen hoods, cooking appliances, etc.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

- 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For wet chemical fire suppression systems.

- 1. Include plans, elevations, sections, and attachment details.
- 2. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: Wet chemical fire suppression systems indicated, to comply with performance requirements and design criteria, including analysis data signed and sealed by the properly licensed (in the State of Illinois) and qualified professional engineer responsible for their preparation.

D. Piping Mapping Plans: Provide/Submit per University requirements to City/Local Jurisdiction and to the University.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Suppression systems, drawn to scale, on which coordination with all adjacent work/conditions are shown/coordinated.

- B. Qualification Data: For qualified Installer and professional engineer.
- C. Approved Suppression System Drawings: Working plans, prepared according to NFPA 17A and NFPA 96, that have been approved by authorities having jurisdiction, including calculations if applicable.
- D. Welding certificates.
- E. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 17A, NFPA 96, and local jurisdiction requirements.
- F. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wet chemical suppression systems and specialties to include in emergency, operation, and maintenance manuals.
- B. Northwestern University Maintenance Requirement Forms, see Division 01 for more information.

1.6 REFERENCES

- A. 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.
- B. FM GLOBAL (FM)
 - 1. FM APP GUIDE: (updated on-line) Approval Guide <http://www.approvalguide.com/>
- C. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
 - 1. NFPA 17A - Standard for Wet Chemical Extinguishing Systems
 - 2. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations
- D. UNDERWRITERS LABORATORIES (UL)
 - 1. UL Fire Prot Directory - Fire Protection Equipment Directory

1.7 QUALITY ASSURANCE

- A. Design and installation Requirements
 - 1. System application, design, and installation shall comply with NFPA 17A and NFPA 96, except as follows:
 - a. Compliance shall include conformance to the advisory provisions by changing "should" to "shall."
 - b. System components shall be listed in UL Fire Prot Dir or approved by FM APP GUIDE for use with wet chemical fire extinguishing systems.

- c. The use of grease extractors does not eliminate the requirement that duct systems, grease removal devices, and hoods be protected by the wet chemical extinguishing system if required.
 - B. Comply with the Illinois Building Code and Fire Code, and required references, the City of Chicago Building Code, Fire Prevention Code, and required references, and with all other requirements of the local Authority Having Jurisdiction (AHJ).
 - C. Submit a statement demonstrating successful completion of similar services on at least five projects of similar size and scope, at least 2 weeks before submittal of other items required by this section.
 - D. Coordination of Trades
 1. Each system shall be coordinated with the equipment, hood, and exhaust ducts that it protects along with other construction in order to eliminate any interference.
 - E. Installation Technician
 1. The installation technician shall have been trained by the system manufacturer for system installation, operation, and maintenance. Concurrent with statement of similar services, submit manufacturer's certification of installation technician.
 - F. Installation Drawings
 1. Provide installation drawings prepared by a representative of the system manufacturer to ensure compliance with the requirements listed herein and with all manufacturer's requirements and recommendations. Submit drawings consisting of system layout including assembly and installation details and electrical connection diagrams; piping layout showing pipe sizes, lengths, and supports. Drawings shall include any information required to demonstrate that the system has been coordinated and will function as intended and shall show system relationship to items it protects and clearances required for operation and maintenance. Submit manufacturer's certification of the drawings. Drawings shall also include conduit, cables, manual actuation stations and fusible links. Include detail drawings for the following items:
 - a. Storage containers and mounting brackets
 - b. Fusible links, cables, conduit, corner pulleys, and link mounting frames/brackets
 - c. Release mechanisms
 - d. Valves
 - e. Discharge nozzles
 - f. Piping components
 - g. Remote manual actuation stations
 - h. Fuel and power shutoff
 - i. Alarms, alarm devices, alarm interface(s), control panels
 - G. Comply with FM Global requirements for general installation of wet chemical systems, and for system inspections, testing and maintenance.
- 1.8 DELIVERY, STORAGE, AND HANDLING
- A. Protect equipment delivered and placed in storage from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Ansul.
- B. Kidde.

2.2 SYSTEM DESCRIPTION

A. General

- 1. Protect each of the following cooking equipment items [____], including the exhaust hood, **[grease extractor,] [grease filter,] and exhaust duct** serving the item by pre-engineered wet chemical fire extinguishing system. System shall be installed with all accessories necessary for system to operate in accordance with manufacturer's instructions and as specified herein.

B. System Controls

- 1. Each system shall be actuated by fusible link and by a remote manual actuation station connected to the extinguishing system release mechanism by cable. Remote manual actuation stations shall be located along the path of egress and shall automatically actuate the **[building] [campus]** fire alarm system, and shall alarm to the facility SCADA system (covered by Division 25). The system controls shall automatically shut off fuel flow and electrical power to the protected appliances and other appliances located under the ventilating system protected by the extinguishing system upon system actuation. All cables used shall be stainless steel with corner pulleys employing stainless steel ball bearings at all corners. All cable and wiring shall be enclosed in conduit.

C. Existing Building Fire Alarm Control Panel

- 1. **The existing building fire alarm control panel was manufactured by [____], Model [____], and presently has [____] spare zone modules. The wet chemical fire extinguishing system shall be connected to [the zone currently serving [____]] [a spare zone module].**

2.3 STANDARD PRODUCTS

- A. Provide system components which are the standard products of a manufacturer regularly engaged in the manufacturing of products that are of similar material, design and workmanship and that have been in satisfactory commercial or industrial use for 2 years before bid opening. The 2-year experience shall include installations of systems under similar circumstances and of similar size. Systems shall be supported by a service organization.
- B. Submit manufacturer's catalog data. The data shall be highlighted to show model, size, options, etc., that are intended for consideration and shall be adequate to demonstrate compliance with contract requirements.
- C. Locate identification signs at each remote manual actuation station. Signs shall be fabricated of rigid plastic, red in color, with engraved white letters that are a minimum 0.25 inches in height.

Each sign shall be engraved with "Wet Chemical Fire Extinguishing System" and with a brief description of the equipment protected.

- D. Replace the fire alarm panel zone identification label with a new label of similar construction which indicates the equipment is connected to the zone module. Discharge of the extinguishing system shall actuate the fire alarm control panel in the same manner as other actuating devices. Extinguishing system wiring shall be supervised in the same manner as other devices connected to the fire alarm system.

2.4 PIPING COMPONENTS

A. Pipe and Fittings

- 1. Pipe and fittings shall be Schedule 40 stainless steel. Stainless steel tubing may be used in accordance with manufacturer's recommendations. Galvanized pipe shall not be used.
- 2. No welding allowed.

B. Nozzles

- 1. Nozzles shall be stainless steel and shall be equipped with an integral strainer to prevent matter inside the distribution piping from clogging the nozzle orifice. Each nozzle orifice shall be provided with a seal to protect the nozzle from clogging by grease or other obstructions. This seal shall detach upon actuation.

2.5 WET CHEMICAL

- A. The wet chemical shall not have an adverse effect on stainless steel during exposure periods of up to 24 hours.

2.6 SPECIAL CONNECTIONS

- A. For any devices/components needed to be monitored/alarmed/supervised, provide each with at least two sets of contacts, one for fire alarm system connection and one for SCADA system connection (refer to Division 25).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be performed by the installation technician in accordance with system manufacturer's instructions. Ductwork access doors shall be provided where indicated and at any items requiring service and inspection, including nozzles and fusible links. Ductwork access doors shall be in accordance with applicable Division 23 Section.

3.2 PRELIMINARY TESTS

- A. Submit proposed test procedures for preliminary test, at least 2 weeks before the start of related testing. System diagrams that show system layout and typed condensed normal and emergency operating procedures, methods for checking the system for normal, safe operation, and procedures for manual actuation shall be framed under glass or laminated plastic. After

approval, these items shall be posted where directed. After installation has been completed, each system shall be actuated by both fusible link and by remote actuation station to demonstrate proper function of all components, including alarms and fuel flow and power shut off. Actuation by fusible link shall be in a manner approved by the system manufacturer. Test containers, pressurized with either nitrogen or air to normal system operating pressure and of the same size as actual operating containers shall be discharged into system. The seals shall release as during normal actuation. After each discharge, the nozzles shall be removed, disassembled, and strainers shall be cleaned. System piping shall be inspected and cleaned as necessary. All functions of system operation shall be verified, including switches, shutdown of fuel and power to appliances protected by the system or served by the same ventilation system, uniform delivery of air or nitrogen, and activation of alarms. Nozzle seals/covers shall be replaced after the preliminary tests are complete. In the event portions of the tests are unsuccessful, repairs shall be made and the entire test repeated until successful. Submit test report for the preliminary tests in booklet form, upon completion of testing. Report shall document test results including repairs and adjustments made, and final test results.

3.3 FINAL ACCEPTANCE TESTS

- A. Submit proposed test procedures for final acceptance test, at least 2 weeks before the start of related testing and proposed test schedule for acceptance test, at least 2 weeks before the start of related testing. System shall be actuated by both fusible link and remote manual actuation station and all system functions shall be verified as described in Paragraph PRELIMINARY TESTS **[using test containers specified for preliminary tests] [except that actual system containers fully charged with wet chemical shall be used]**. Each nozzle shall be provided with a plastic container, hose, and hose fitting to capture all wet chemical discharged. All tests or checks recommended by the manufacturer shall also be performed. In the event portions of the tests are unsuccessful, repairs shall be made and the entire test repeated until successful. Nozzle seals/covers shall be replaced after the final acceptance tests are complete. The system shall be returned to normal operating condition after the completion of testing and wet chemical containers expended shall be recharged and verified leak tight. Extinguishing system and equipment and duct protected by the extinguishing shall be cleaned after completion of testing. Any damage shall be repaired by the Contractor. The weight of each storage container shall be recorded before final acceptance test and after test has been completed and containers recharged. Submit test report for the final acceptance tests in booklet form, upon completion of testing. Report shall document test results including repairs and adjustments made, and final test results. The weight of each storage container shall be recorded before final acceptance test and after test has been completed and containers recharged.

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3.4 FIELD TRAINING

- A. Submit proposed schedule for field training, at least 2 weeks before the start of related training. Conduct a training course for operating and maintenance personnel as designated by the University. Training shall be provided for a period of [_____] hours of normal working time and shall start after the system is functionally complete and after the Final Acceptance Test. The field instruction shall cover all of the items contained in the approved Operation and Maintenance Instructions. Submit **[6]** [_____] manuals listing step-by-step procedures required for system actuation (automatic and manual), recharging, and routine maintenance, at least 2 weeks before field training. The manuals shall include the manufacturer's name, model number, parts list, list of tools and parts that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and control diagrams, troubleshooting guide, and recommended service organization (including address and telephone number). Service organization shall be capable of providing **[4]** [_____] hour onsite response to a service call on an emergency basis.

END OF SECTION 21 2400WC

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