HSE Department

METHOD STATEMENT

FOR

Automatic Sprinkler, FM-200 (HFC-227ea) Clean Agent and Foam Systems — Installation, Testing, Commissioning and Handover

PROJECT: ABC

Location:

	Prepared By	Reviewed By	Approved By
Name	Name Here		
Designation	Name Here	Project Engineer	Project Manager
Company	Company Name	Company Name	Company Name
Signature			
Date	Date Here		

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Prepared in accordance with NFPA, ISO, FM Global and HSE/QHSE requirements. Project-specific entries are shown in [square brackets] and must be completed before issue.

Document Control

Item	Detail
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Revision History

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1. Purpose

1.1 This Method Statement defines the methodology, sequence of work, resources, quality controls and HSE measures for the installation, testing, commissioning and handover of the Fire Fighting Systems at [Project name], comprising:

- Automatic Sprinkler System (wet pipe, and dry/pre-action where applicable) with fire pump set, water storage, and underground fire main.
- FM-200 (HFC-227ea) total flooding clean agent system for [server rooms, electrical rooms, control rooms, data halls].
- Foam system (foam-water sprinkler, foam chamber, high-back-pressure or low-expansion foam as applicable) for [fuel storage, generator fuel area, loading bay, hazardous area].

1.2 The document ensures the work is executed safely, to the approved design and specification, and in compliance with NFPA, ISO, FM Global, manufacturer requirements, and requirements of the Authority Having Jurisdiction (AHJ).

2. Scope of Work

2.1 Included

- Review of approved shop drawings, hydraulic calculations and gas/foam design calculations.
- Procurement, inspection, storage and handling of approved materials.

- Installation of pipework, supports, fittings, valves, sprinklers, nozzles, detector interfaces, and accessories.
- Installation of fire pump set (electric duty, diesel standby, jockey pump), controllers, and test header.
- Installation of FM-200 cylinders, manifolds, discharge nozzles, release panels, manual release and abort stations, alarm devices, and room integrity provisions.
- Installation of foam concentrate tank, proportioning equipment, foam pourers/chambers, foam-water deluge valves and discharge devices.
- Flushing, hydrostatic and pneumatic testing, functional testing, integration testing with the fire alarm system, and third-party / AHJ acceptance.
- Training, as-built documentation, operation and maintenance manuals, and handover.

2.2 Excluded (by others unless noted)

- Building structure, penetration sleeves by civil (unless in scope), power supply to the point of connection, fire alarm panel supply (interface only), and architectural room sealing beyond what is agreed for FM-200 enclosure integrity.

3. Definitions and Abbreviations

Term	Meaning
AHJ	Authority Having Jurisdiction (e.g., Civil Defence, Fire Marshal)
ITP	Inspection and Test Plan
MIR / MAR	Material Inspection Request / Material Approval Request
WIR	Work Inspection Request
RAMS	Risk Assessment and Method Statement
PTW	Permit to Work
QHSE	Quality, Health, Safety and Environment
FACP	Fire Alarm Control Panel
FM-200	HFC-227ea (heptafluoropropane) clean agent
NOAEL / LOAEL	No / Lowest Observed Adverse Effect Level
AFFF / AR-AFFF	Aqueous Film Forming Foam / Alcohol-Resistant AFFF
F3	Fluorine-free foam
ESFR	Early Suppression Fast Response sprinkler
OS&Y	Outside Screw and Yoke (valve)
PPE	Personal Protective Equipment
LOTO	Lock-Out Tag-Out
SDS	Safety Data Sheet
UL / FM / LPCB	Third-party listing/approval bodies

4. Codes, Standards and References

The works shall comply with the latest edition adopted by the AHJ and the project specification. Where requirements conflict, the more stringent requirement shall apply, subject to the Engineer’s direction.

4.1 NFPA (National Fire Protection Association)

Standard	Title / Application
NFPA 13	Installation of Sprinkler Systems
NFPA 14	Standpipe and Hose Systems
NFPA 15	Water Spray Fixed Systems
NFPA 16	Foam-Water Sprinkler and Foam-Water Spray Systems
NFPA 11	Low-, Medium- and High-Expansion Foam
NFPA 20	Installation of Stationary Pumps for Fire Protection
NFPA 22	Water Tanks for Private Fire Protection
NFPA 24	Private Fire Service Mains and Their Appurtenances
NFPA 25	Inspection, Testing and Maintenance of Water-Based Fire Protection Systems
NFPA 2001	Clean Agent Fire Extinguishing Systems
NFPA 72	National Fire Alarm and Signaling Code
NFPA 70 / NFPA 70E	National Electrical Code / Electrical Safety in the Workplace
NFPA 10	Portable Fire Extinguishers
NFPA 30	Flammable and Combustible Liquids Code
NFPA 101 / NFPA 1	Life Safety Code / Fire Code
NFPA 51B	Fire Prevention During Welding, Cutting and Other Hot Work
NFPA 750 / 770	Reference where water mist or hybrid systems are specified

4.2 ISO and International Standards

Standard	Application
ISO 14520 (Parts 1–15)	Gaseous fire-extinguishing systems – physical properties and system design (Part 9: HFC-227ea)
ISO 6182 series	Automatic sprinkler system components (sprinklers, valves, alarm devices)
ISO 7240 series	Fire detection and alarm systems
ISO 7010	Graphical symbols – safety colours and safety signs
ISO 9001	Quality Management Systems
ISO 14001	Environmental Management Systems
ISO 45001	Occupational Health and Safety Management Systems
ISO 31000	Risk management guidelines
ISO 7-1 / ISO 228-1	Pipe threads
ISO 10931 / ISO 2531	Piping and ductile iron pipe (as applicable)
ISO 5817 / ISO 9606-1	Welding quality and welder qualification
ISO 4126	Safety devices against excessive pressure (relief)
BS EN 12845 / EN 12094	Referenced where specified for sprinklers and gas system components

4.3 Third-Party Approvals and Property Insurer Requirements

- UL / ULC listing and FM Approvals for all sprinklers, valves, pumps, controllers, flow switches, tamper switches, FM-200 valves/nozzles/release devices and foam equipment.

- FM Global Property Loss Prevention Data Sheets (e.g., DS 2-0 Installation Guidelines for Automatic Sprinklers, DS 4-2 Water Mist, DS 4-9 Halocarbon and Inert Gas Clean Agent Systems, DS 4-12 Foam Extinguishing Systems), where required by the insurer.
- LPCB / VdS approvals where specified.

4.4 Local Regulations

- [UAE Fire and Life Safety Code of Practice (Ministry of Interior), and local Civil Defence requirements – or the applicable national/local fire code for the project country.]
- Local municipality and utility regulations, and the project-specific Employer's Requirements and Specification (Section [ ]).

4.5 HSE / QHSE Regulations and Guidance

- ISO 45001 and the Contractor's HSE Management Plan.
- Local labour and OSH law, and Employer's HSE requirements (e.g., [Dubai Municipality / Trakhees / client HSE standards]).
- OSHA 29 CFR 1926 (Construction Standards) – used as international best-practice benchmark for work at height, excavation, confined space, electrical safety and hazard communication.
- Manufacturer installation, operation and safety instructions, and SDS for agent and foam concentrate.

5. Roles and Responsibilities

Role	Responsibilities
Project Manager	Overall responsibility for planning, resources, schedule, compliance with this Method Statement, and liaison with Client and AHJ.
Site Manager / Construction Manager	Day-to-day execution, coordination with other trades, enforcement of sequence, PTW compliance.
Project / Design Engineer	Shop drawings, hydraulic and gas/foam calculations, technical submittals, RFIs, as-builts.
QA/QC Engineer	Implement ITP, inspect materials and works, witness tests, maintain records, raise and close NCRs.
HSE Manager / Officer	Risk assessments, inductions, toolbox talks, inspections, incident reporting, enforcement of PPE and PTW.
Foreman / Supervisors	Direct crews, ensure safe working method, verify tools and access equipment, sign daily checklists.
Pipefitters, Welders, Electricians, Technicians	Perform work per approved drawings and method; hold valid trade and safety certifications.
Commissioning Engineer	Execute flushing, testing, functional and integration tests; compile commissioning records.
Manufacturer's Representative	Supervise/approve FM-200 and foam equipment installation, commissioning and training; issue certificates.
Client / Consultant	Review submittals, witness critical tests, and issue approvals and acceptance.
AHJ / Third-Party Inspector	Inspect, witness acceptance tests, and issue final approval or completion certificate.

6. Project and System Description

6.1 Project Overview

[Insert brief description: building type, number of floors, areas, occupancy classifications, and hazard classifications – e.g., Light Hazard offices, Ordinary Hazard Group 2 car parks, Extra Hazard flammable liquid storage, data hall.]

6.2 Water-Based Sprinkler System

- Water source: [Underground/Above-ground fire water tank – capacity [ ] m³ per NFPA 22 / NFPA 13 duration requirement].
- Pump set: [Electric duty pump [ ] L/min at [ ] bar, diesel standby pump, jockey pump] per NFPA 20, with automatic controllers and test header.
- Distribution: Underground ring main per NFPA 24, risers, floor control valve sets (OS&Y/butterfly with tamper switch, flow switch, test and drain), and branch/cross mains.
- Sprinklers: pendent, upright, sidewall, concealed, and [ESFR] types, with temperature ratings and K-factors per hydraulic calculation.
- Hydraulic design: Density/area method or room design method per NFPA 13 with allowance for hose stream.

6.3 FM-200 System

- Total flooding of [list protected rooms and volumes].
- Design concentration: [__ %] by volume at minimum room temperature of [__ °C] per NFPA 2001 / ISO 14520-9, with discharge time not exceeding 10 seconds.
- Agent storage: [number] cylinders at [25 bar / 42 bar] super-pressurised with nitrogen, with main and reserve bank where specified.
- Detection and control: Dual-zone cross-zoned smoke detection, release control panel, manual release, abort, pre-discharge alarm/strobe and discharge indicator, per NFPA 2001 and NFPA 72.

6.4 Foam System

- Protected hazard: [e.g., diesel generator fuel tanks, flammable liquid storage, loading rack, hangar].
- System type: [Fixed foam-water deluge/sprinkler system per NFPA 16 / foam chamber on tank per NFPA 11 / high-expansion generator].
- Foam concentrate: [AFFF/AR-AFFF/F3] at [1%, 3% or 6%] proportioning; [Type, manufacturer, listing].
- Proportioning: [Bladder tank / balanced-pressure pump / in-line balanced pressure / around-the-pump] with discharge densities and application rate as per NFPA 11 / NFPA 16 and design calculations.

7. Documentation, Submittals and Quality Control

7.1 Documents Required Before Start of Work

Item	Status
Approved shop drawings (plans, risers, sections, details, supports)	Required
Approved hydraulic calculations (NFPA 13/24/20)	Required
FM-200 flow calculation (manufacturer's listed software) and enclosure integrity calculation	Required
Foam system calculations (application rate, concentrate quantity, proportioner sizing)	Required

Item	Status
Material submittals, datasheets, UL/FM listings, test certificates	Approved
Approved ITP and checklists	Approved
This Method Statement and Risk Assessment	Approved
Civil Defence / AHJ approved drawings	Approved
Welder qualification records (WPS/PQR/WPQ) and personnel certificates	Valid
Calibration certificates for gauges, flow meters, door fan and testing equipment	Valid

7.2 Quality Control Procedure

1. All materials delivered to site are inspected under a Material Inspection Request (MIR) and compared against approved submittals.
2. Each stage of work is inspected under a Work Inspection Request (WIR), submitted with at least 24 hours notice to the Consultant/Client.
3. Hold Points (H) require written approval before proceeding; Witness Points (W) allow attendance by the Client/Consultant; Review Points (R) are document reviews.
4. Non-conformances are recorded in an NCR, with root cause, corrective and preventive actions, and closure verification.
5. Records are maintained in the QA/QC dossier and submitted at handover.

7.3 Quality Management

The QA/QC process shall comply with the Contractor's ISO 9001 Quality Management System and Project Quality Plan.

8. Materials, Equipment and Approvals

8.1 Material Summary

Item	Specification / Standard	Notes
Steel pipe 50 mm and below	ASTM A53 Gr. B / A795, Schedule 40 (ERW or seamless), threaded or grooved	Black steel; galvanized for dry/pre-action systems
Steel pipe 65 mm and above	ASTM A53 / A135, Schedule 10 or 40 per hydraulic design; grooved or welded	Wall thickness per NFPA 13 and listed grooved coupling limits
Fittings	UL/FM listed grooved couplings, ASME B16.3 / B16.9	Pressure rating at least 175 psi (12 bar) or as designed
Valves	UL/FM listed OS&Y gate, butterfly with tamper switch, check, alarm check, deluge, pre-action	Rated per ISO 6182 / UL 262 / FM 1112
Sprinklers	UL/FM listed, ISO 6182-1	Correct K-factor, orifice, temperature rating, finish
Underground pipe	Ductile iron (AWWA C151 / ISO 2531), HDPE or GRP (UL/FM listed)	Per NFPA 24, with thrust blocks or restrained joints
FM-200 agent	HFC-227ea per ISO 14520-9 / NFPA 2001, purity per ASTM D6064	Supplied by manufacturer with certificate of conformity

Item	Specification / Standard	Notes
FM-200 cylinders, valves, nozzles	UL/FM/VdS listed; DOT/TPED/ISO 9809 cylinders	Hydrostatic test dated within 5 years
FM-200 piping	ASTM A106 Gr. B seamless Schedule 40 (or 80 where required)	Fittings forged 3000 lb; no cast iron; galvanized or internally clean
Foam concentrate	UL 162 / ICAO / EN 1568 as applicable	Compatible with equipment; SDS on file
Foam proportioners, chambers, pourers	UL/FM listed	Per NFPA 11/16
Fire pumps and controllers	UL/FM listed, NFPA 20	Pump curve with 150% flow at not less than 65% pressure
Pipe supports and hangers	UL listed per NFPA 13 Ch. 17	Seismic bracing where required
Signage	ISO 7010 and NFPA 13/2001/16 requirements	Identification, warning, valve, and system signs

8.2 Storage and Handling

- Materials stored on pallets, off the ground, in a designated covered laydown area, protected from moisture, dirt and mechanical damage.
- Pipe ends capped; sprinklers kept in original boxes and protected from impact, paint and chemicals; never use sprinklers that have been dropped or have damaged coatings.
- FM-200 cylinders stored upright and secured with chains/straps in a cool, ventilated area, kept away from heat above 50 °C, with valve protection caps installed until final connection.
- Foam concentrate stored in original sealed containers in shaded, temperature-controlled space, within the manufacturer's limits, with spill containment.
- Handling heavy items (pumps, tanks, cylinders) done by trained riggers using certified lifting equipment and lifting plans.

9. Pre-Construction Activities and Mobilization

1. Hold kick-off meeting with Client, Consultant, Main Contractor and HSE representatives.
2. Submit and obtain approval of RAMS, ITP, shop drawings, and material submittals.
3. Verify site conditions: ceiling heights, structure, MEP clashes, and builders' work readiness; coordinate with the BIM/coordination team to resolve clashes before fabrication.
4. Mobilize competent manpower, tools, scaffolding/MEWPs, lifting equipment and welfare facilities.
5. Conduct site induction and task-specific toolbox talk for all personnel.
6. Establish and agree laydown, workshop, prefabrication and waste areas.
7. Arrange third-party inspection of lifting equipment, scaffold tags, and electrical equipment.
8. Confirm utilities and isolation arrangements, including temporary water, power and the route for flushing discharge.
9. Carry out a pre-start walk-down with the Client to verify work fronts and access.

10. Health, Safety and Environment (HSE) Requirements

10.1 HSE Policy and Management

Work shall be carried out under the Contractor's ISO 45001-aligned HSE Management System and the project HSE Plan. Zero harm is the objective. All personnel have the right and duty to stop unsafe work.

10.2 General Requirements

- Valid site induction card and trade competency for every worker; supervisors hold a recognised safety qualification (e.g., NEBOSH / OSHAD / IOSH or equivalent).
- Approved RAMS and a signed PTW for each high-risk activity.
- Daily toolbox talks, pre-task briefings (JSA/JHA), and weekly HSE inspections.
- Housekeeping: clean, tidy work area; waste segregated and removed daily.
- Incident reporting: all accidents, near misses and unsafe conditions reported immediately to the HSE Officer; serious incidents notified to the Client and authorities within required timeframes.
- First aid: trained first aiders and equipped first-aid kit on site; emergency contact numbers displayed.

10.3 Personal Protective Equipment (PPE)

PPE	Standard / Use
Safety helmet with chin strap	EN 397 / ANSI Z89.1 – mandatory at all times on site
Safety shoes (steel toe and midsole)	EN ISO 20345 / ASTM F2413
High-visibility vest	EN ISO 20471
Safety glasses / goggles	EN 166 / ANSI Z87.1
Gloves (cut/chemical/welding as required)	EN 388 / EN 374 / EN 12477
Hearing protection	EN 352 when noise exceeds 85 dB(A)
Welding helmet, apron and leathers	EN 175 / EN ISO 11611
Respiratory protection (P2/P3, organic vapour)	EN 149 / EN 140 – grinding, welding fume, foam handling
Full-body harness with double lanyard	EN 361 / EN 355 – work at height above 1.8 m (or per local limit)
Chemical splash goggles, apron, gloves	For foam concentrate and agent handling per SDS

10.4 Specific Safety Controls

Work at height: Use only inspected and tagged scaffolds, MEWPs or podium steps; operators trained and certified; harness anchored where required; no work from unsecured ladders except for short-duration light work with three points of contact; exclusion zone below overhead work.

Hot work (welding, cutting, grinding): Hot Work Permit per NFPA 51B; remove or cover combustibles within 11 m (35 ft); fire watch during work and for at least 30 minutes after; fire extinguisher and fire blanket at the work point; welding screens; fume extraction or ventilation; gas cylinders secured upright with flashback arrestors.

Lifting operations: Lifting plan and appointed person; certified slings, shackles and equipment; trained rigger and signalman; no one under suspended loads; pumps, tanks and cylinders lifted only at designated points.

Excavation (underground main): Excavation permit; utility drawings and CAT/GPR scan; trench shoring or sloping where deeper than 1.2 m; safe access and egress (ladder within 7.5 m of workers); barricades, lighting and signage; spoil kept at least 1 m from edge; daily competent-person inspection; dewatering control.

Pressure testing: Test only after approval of the test procedure; barricade the area and post warning signs; use calibrated gauges rated at least 1.5 times test pressure; relief valve fitted; no person to stand in line with blind flanges or plugs; bleed air fully before pressurising; depressurise slowly after test; gauges and hoses inspected before use.

Electrical safety: Work only by qualified electricians; LOTO procedure per NFPA 70E; RCD-protected temporary power at 110 V or per site rule; cables protected from damage; inspected and tagged tools only.

Confined space (tanks, pits, valve chambers): Confined Space Entry Permit; atmospheric testing (O_2, LEL, H_2S, CO) before and during entry; ventilation; standby person; rescue plan and equipment; communication.

Manual handling: Mechanical aids used for items above 20 kg; team lifts and correct lifting technique; trolleys for pipe and cylinders.

Chemical handling: SDS available at point of use; foam concentrate and FM-200 handled per manufacturer instructions; eye-wash and spill kits available; spills contained and cleaned using absorbents and disposed of via licensed contractor.

Heat stress and hydration (hot climates): Cooling/rest breaks during peak heat, drinking water and shade at work areas, and work restrictions in line with local midday work-ban rules (e.g., 12:30–15:00, 15 June–15 September in the UAE).

Gas discharge safety (FM-200): The FM-200 system is kept in "manual/locked-off" mode and discharge heads disconnected (actuators removed or safety pins installed) throughout installation and testing, and only restored to automatic mode on final authorised commissioning sign-off; protected rooms must be evacuated and secured before any agent-related test.

11. General Installation Methodology (Common to All Systems)

11.1 Sequence of Work

Stage	Activity	Control
1	Review approved drawings, coordinate with MEP/structure, mark-out	Coordination sign-off
2	Material receipt, inspection and approval (MIR)	Hold Point
3	Underground fire main, tanks, pump room (if in scope)	WIR / Witness
4	Sleeves, supports, hangers and pipe prefabrication	WIR
5	Riser and main installation	WIR
6	Branch lines, sprinklers/nozzles (trim-out last), cylinders, foam equipment	WIR
7	Flushing	Witness Point
8	Hydrostatic / pneumatic tests	Hold Point
9	Electrical and detection/control interface	WIR
10	Functional, integration and acceptance tests	Hold Point
11	Snagging, as-builts, training and handover	Review Point

11.2 Setting Out and Coordination

1. Mark centrelines, levels, sleeve positions and hanger locations from approved shop drawings using laser level and chalk line.
2. Confirm clearances to structure, ducts, cable trays, lighting and ceiling grid; sprinkler deflector distance to ceiling and obstruction rules are maintained per NFPA 13.
3. Resolve clashes through the approved coordination process; any deviation from approved drawings requires an approved RFI or Engineer's instruction before work proceeds.
4. Verify fire-rated penetrations: sleeves installed and later sealed with approved fire-stop systems, per the passive fire protection specification.

11.3 Pipe Fabrication and Joining

- **Cutting:** Square cut using pipe cutter or band saw; ends reamed and deburred; no flame cutting of pipe unless approved.

- **Grooving:** Roll or cut grooving per coupling manufacturer's dimensions; groove dimensions verified with a groove gauge; gaskets and couplings from the same listed manufacturer; bolts tightened evenly with pad-to-pad contact.
- **Threading:** Taper threads to ASME B1.20.1 / ISO 7-1; thread sealant (PTFE tape or listed compound) applied to male threads only; no more than 3 exposed threads.
- **Welding:** Welded by qualified welders to approved WPS (ISO 15614 / ASME IX); welds free from slag, burn-through and internal protrusions; mechanical hole saw for outlets with coupons retrieved; hot work permit for any in-place welding, and NFPA 13 welding restrictions observed.
- **Flanged joints:** Gaskets compatible with fluid; flange bolts tightened in a cross pattern to specified torque.
- **Cleanliness:** Pipe interiors inspected and cleared of debris, oil and swarf; open ends capped at all times.

11.4 Supports, Hangers and Bracing

1. Hangers UL-listed and sized per NFPA 13 Chapter 17, spaced to the maximum allowable distance for the pipe size and material, or shorter where required by listing.
2. Hanger rods sized to pipe diameter; anchors suitable for the substrate, with pull-out testing where required.
3. A hanger is installed within the NFPA 13 maximum distance of the end of each pipe run and at each sprinkler-bearing branch line as applicable.
4. Seismic and sway bracing and restraints per NFPA 13 Chapter 18 where the design requires them.
5. No support from other services, ductwork or ceiling grid unless specifically listed.
6. Pipe isolated from dissimilar metals and sleeved through walls with proper clearance.

11.5 Identification and Labelling

- Pipes painted or labelled red (RAL 3000 or as specified) with directional arrows and system name at intervals per specification.
- Valves tagged and numbered; hydraulic design data placards fixed to each riser/control valve; general information signs per NFPA 13.
- Foam and FM-200 equipment labelled with system identification, contents and warnings per NFPA 11/2001 and ISO 7010.

11.6 Quality Checks During Installation

- Daily visual checks of alignment, supports, clearances and joint completeness.
- Torque and grooving records maintained for risers and mains.
- Photographs taken before concealment of pipework and recorded in the WIR.
- Open-end protection verified at end of each shift.

12. Automatic Sprinkler System – Installation Method

12.1 Underground Fire Main (NFPA 24)

1. **Excavation:** After excavation permit and utility scan, excavate to the required depth (cover per NFPA 24 and local conditions); trench width allows safe joint assembly; bedding of 100 mm clean sand or approved fill.
2. **Pipe laying:** Inspect each length for cracks and damage; lay to line and level; clean joints and lubricate gaskets; lower using approved slings; maintain joint deflection within manufacturer limits.
3. **Restraints:** Thrust blocks or restrained joints at tees, bends, plugs, hydrants and valves per NFPA 24 and approved design; concrete thrust blocks allowed to cure before pressure testing, unless restrained joints are used.
4. **Valves and hydrants:** Indicating valves installed with valve boxes; hydrants set on firm base with drainage gravel, outlets oriented as required.

5. **Backfill:** Compact in layers of 150 mm to specified density; place marker tape 300 mm above pipe and tracer wire where required; keep joints exposed until testing is completed if required by the Consultant.
6. **Flushing:** Flush underground piping at a flow rate not less than system demand, or the maximum flow available, until water runs clear, before connecting to risers (NFPA 24 and NFPA 13).
7. **Hydrostatic test:** 14 bar (200 psi) for 2 hours, or 3.4 bar (50 psi) above maximum static pressure where it exceeds 10.3 bar (150 psi); allowable leakage per NFPA 24; no visible leakage at joints; test witnessed and recorded.

12.2 Fire Water Tank and Pump Room (NFPA 22 / NFPA 20)

1. **Tank:** Install per approved design on prepared foundation; verify capacity, level indicators, low/high level alarms, overflow, vent, sump, anti-vortex plate and suction connections; tank cleaned and disinfected prior to filling, with internal inspection under a confined space permit.
2. **Pump set installation:** Position on concrete base with correct grouting; align coupling and verify with dial indicator; install suction and discharge piping with eccentric reducer (flat on top) on suction and concentric on discharge, observing the NFPA 20 straight-run requirement before the pump suction flange.
3. **Accessories:** Install OS&Y or butterfly valves with supervisory switches on suction and discharge; check valve; pressure gauges; casing relief valve; automatic air release; flow meter or test header with hose valves; jockey pump with controller; pressure sensing lines per NFPA 20.
4. **Diesel engine:** Install fuel tank, batteries, exhaust with silencer, cooling arrangement and ventilation; fill with fuel and lubricants; verify two battery banks and automatic charger.
5. **Controllers:** Mount and wire to power supply; verify normal and alternate source, phase protection, and alarm signalling to the FACP; power supply installed with dedicated, protected feeders per NFPA 20 and NFPA 70.
6. **Pump room:** Provide drainage, lighting, ventilation, minimum room temperature and emergency lighting as required.

12.3 Riser, Mains and Control Valve Assemblies

1. Install risers vertically using clamps and sway bracing; install control valve, check valve, flow switch, tamper switch, pressure gauge, test and drain valve and drain piping to a safe discharge point.
2. Floor control valve sets complete with supervised isolation valve, flow switch, test and drain connection and pressure gauges, positioned in an accessible area.
3. Install Fire Department connection per NFPA 13/14 with check valve, drain and caps, accessible and signposted.
4. Alarm check valve or deluge/pre-action valve trim assembled per manufacturer instructions, with water motor gong or electric alarm; verify trim orientation and drainage.

12.4 Branch Lines, Cross Mains and Drains

1. Install cross mains and branch lines to design layout; pipe pitched to drain points as required by NFPA 13 (dry and pre-action pipework requires greater pitch than wet pipe).
2. Install auxiliary drains and low-point drains per NFPA 13; inspector’s test connection at the hydraulically most remote location, with orifice equal to the smallest sprinkler orifice and discharge to a safe location.
3. Flexible sprinkler drops only where listed and within allowed lengths and bending radius; arm-overs and sprigs per design.
4. Install pressure relief where required, and air maintenance device and compressor for dry pipe systems.
5. Protect pipework in areas subject to freezing, corrosion or mechanical damage; provide flexible couplings where crossing building expansion joints.

12.5 Sprinkler Installation (Trim-Out)

1. Install sprinklers only after piping is flushed and pressure tested, and when ceilings or finishes allow final positioning, to prevent painting or damage.

2. Verify sprinkler type, K-factor, temperature rating and finish against approved drawings and hydraulic calculation; use only the specified sprinkler wrench.
3. Position sprinklers per NFPA 13 spacing: maximum coverage per sprinkler and distance from walls, obstructions, beams, lights and diffusers; deflector-to-ceiling distance within listing.
4. Concealed sprinklers: install cover plates after ceiling finishing and painting; adjust to ceiling surface within listed range.
5. Install sprinkler guards where subject to mechanical damage and corrosion-resistant types in corrosive atmospheres.
6. Provide a spare sprinkler cabinet with the spare heads and wrench required by NFPA 13, including each type and rating installed.

12.6 Special Systems Within Scope

- **Dry pipe / pre-action:** Galvanized pipe, air or nitrogen supply, and water delivery time test to the most remote inspector's test connection, per NFPA 13 limits.
- **Deluge system:** Open sprinklers/nozzles, deluge valve, detection system; verify releasing circuit and manual release; full flow test with Client approval.
- **ESFR / high-piled storage:** Verify obstruction clearances and storage configuration per NFPA 13 and FM Global data sheets.
- **Standpipe and hose cabinets (NFPA 14):** Install riser, landing valves, pressure-reducing valves where required, hose cabinets, and perform flow test at the most remote outlet.

12.7 Flushing, Pressure Testing and Commissioning of Sprinkler System

Procedures are described in Section 15. In summary: flush mains and risers; hydrostatic test at 14 bar (200 psi) for 2 hours (or 3.4 bar above working pressure when higher); air test of dry pipe at 2.8 bar (40 psi) for 24 hours with pressure loss not exceeding 0.1 bar (1.5 psi); main drain test; alarm test; and hydraulic verification.

13. FM-200 Clean Agent System – Installation Method

Installation, commissioning and testing shall follow NFPA 2001, ISO 14520-1 and ISO 14520-9, NFPA 72, and the manufacturer's listed design, installation and maintenance manual (DIOM). Only manufacturer-trained and certified technicians shall install or commission the system.

13.1 Design Verification

Parameter	Requirement
Design concentration	Not less than the minimum design concentration for the hazard class per NFPA 2001 / ISO 14520-9 (Class A surface fire minimum 6.7% by volume; Class B and electrical hazards per cup-burner derived value with safety factor), adjusted for minimum room temperature and altitude
Discharge time	Not more than 10 seconds to achieve not less than 95% of design concentration
Hold time	Minimum 10 minutes at not less than 85% of design concentration at the highest protected level, unless the specification requires longer
Occupied-space exposure	Normally occupied areas not to exceed the NOAEL of 9.0%; exposure up to the LOAEL of 10.5% only with limited time per NFPA 2001 tables and pre-discharge alarm and egress controls
Reserve supply	As specified (main/reserve banks) for critical facilities
Pipe network	Within the limits of the listed flow calculation (pipe lengths, fill ratio, nozzle pressure)

Before installation, the Engineer verifies the room volume (net of permanent non-removable obstructions), design temperature, leakage areas, agent quantity and pipe sizing against the manufacturer's approved calculation, and confirms any change on site with the manufacturer before proceeding.

13.2 Enclosure Preparation

1. Coordinate with the Main Contractor to complete the room envelope: walls extended slab to slab, fire-stopped penetrations, sealed cable and pipe entries, and tight-fitting doors with closers and threshold seals.
2. Provide automatic dampers or closure of HVAC supply, return, and exhaust openings on discharge signal, and shutdown of air-handling units.
3. Provide pressure relief venting only where determined necessary by the calculation, to prevent structural overpressure; this is confirmed with the manufacturer.
4. Confirm that raised floor and ceiling void are included in protected volume if they are not separated.
5. Check that sprinkler or other water services are not routed through the protected room unless approved.

13.3 Cylinder and Manifold Installation

1. Position the cylinder bank on the prepared and levelled floor or wall using manufacturer-approved racks and brackets anchored to the structure; the surface must support the full weight of the filled cylinders.
2. Cylinders stored within the temperature range specified for the agent (typically 0 °C to 50 °C) in the cylinder room, not exposed to direct sunlight or heat sources.
3. Install cylinders upright with straps/clamps, gauge visible, nameplate and weight label readable; do not remove transport caps until just before connecting.
4. Install discharge hoses and check valves to manifold; connect actuation lines (pilot lines) where cylinders are in a multiple bank configuration; torque fittings to the manufacturer's values.
5. Leave actuators disconnected, safety pins installed, and discharge outlet caps fitted until the final commissioning stage.
6. Fit a pressure switch or low-pressure supervisory device and weighing/level monitoring devices where specified.

13.4 Piping and Nozzle Installation

1. Use seamless steel pipe ASTM A106 Gr. B or A53 Type S, Schedule 40 (Schedule 80 where required by the manufacturer's listing), with forged steel fittings; cast iron fittings are not permitted.
2. Pipe fabrication: cut, ream, and clean inside; remove oil or contaminants by approved solvent or compressed air where required; protect open ends.
3. Support pipe at intervals recommended by the manufacturer and NFPA 2001; provide a support within the manufacturer's limit of each nozzle, and brace to resist discharge reaction forces.
4. Take-offs from the main must be configured to ensure balanced flow, with tees installed with side outlets (bull-head tees only where listed), and with fittings orientation as in the approved flow calculation.
5. Install nozzles in positions, orientations and orifice sizes exactly as per approved drawings and flow calculation; verify nozzle type (180° or 360°), height, and clearance from obstructions; protect nozzles from construction dust using caps removed only at completion.
6. Weld pipe joints per qualified procedure; threaded joints sealed with approved sealant on male threads only, kept clear of the pipe interior.
7. Ensure pipe is electrically bonded and earthed where required, and that no pipe section is trapped between closed valves without pressure relief.
8. Mark piping and valves with identification and flow direction labels.

13.5 Detection, Control and Alarm Interface

1. Install the release control panel (or FACP releasing module) in an accessible, monitored location; wire per NFPA 72 and the manufacturer's instruction with supervised circuits (open, short, ground-fault).

2. Install smoke or multi-criteria detectors in two cross-zoned circuits (Zone A and Zone B), spaced per NFPA 72 and ISO 7240, including under raised floors and above false ceilings where protected.
3. Install manual release (electric manual pull) and abort stations at each exit, in accordance with NFPA 2001 (abort switch is of a type that requires constant manual operation and is not a latching device unless specified and approved).
4. Install pre-discharge sounders and visual alarms inside the room, outside warning strobes at entrances, and “Agent Released” lamp, along with signs: “FM-200 System Protected Area – Do Not Enter When Alarm Sounds” and ISO 7010 warning pictograms.
5. Configure the time delay (typically 30–60 seconds, as approved by the AHJ and Consultant) and pre-discharge alarm; verify that delay is not shortened below the approved egress time.
6. Wire interface to: HVAC shutdown and damper closure, door holders release, power shutdown (where specified), BMS, and main FACP.
7. Install a lockout/maintenance disable switch with supervisory signal.
8. Fit secondary or standby power (24 hours standby plus 5 minutes alarm, or 24 hours plus 30 minutes for a remote supervising signal, as per NFPA 72 and the specification).

13.6 Safety Controls During FM-200 Installation

- No agent cylinder is connected to the actuation system until all piping tests and enclosure tests are accepted, and the Client’s written authorisation for “live” status is given.
- The release panel is kept in the “Disabled/Maintenance” condition and the Client’s control room is informed before any detection testing in the room.
- Cylinders handled with approved trolleys and lifting equipment, with valve protection caps on; cylinders are never dropped, rolled or used as supports.
- All people are cleared from the room and the area is posted before the pipe test or any agent discharge.
- Contractor ensures a tag-out of the system when work or testing is incomplete at the end of a shift.

14. Foam System – Installation Method

Work shall follow NFPA 11, NFPA 16, NFPA 15 (where water spray is used), NFPA 20, the foam manufacturer’s instructions and approved design calculations.

14.1 Foam Concentrate Selection and Environmental Compliance

1. The foam concentrate type, proportioning percentage and listing must match the hazard (hydrocarbon or polar solvent), the proportioner and the discharge devices; compatibility confirmed with the manufacturer in writing.
2. Where fluorine-free (F3) or PFAS-restricted concentrate is required by the Client or regulation, verify performance listing for the specific hazard and equipment.
3. Foam concentrate quantity is verified against the design calculation (application rate, discharge duration, piping fill and a reserve as required, i.e., NFPA 11 and NFPA 16 minimums).
4. SDS and environmental data are reviewed; discharge, test and disposal arrangements comply with the environmental plan (Section 19). Fluorinated foam is not discharged to drains, soil or waterways.

14.2 Foam Storage Tank and Proportioning Equipment

1. Install the foam concentrate tank, bladder tank, or foam pump skid on a level concrete base, anchored per the manufacturer; leave clearance for maintenance and refilling; provide secondary containment bund.
2. Install the proportioner (in-line balanced pressure, pump-based balanced pressure, bladder tank with ratio controller, or around-the-pump) in the position and flow direction required, with correct straight run before and after as stated in the manufacturer’s data.
3. Connect water supply, concentrate and solution lines using compatible materials (stainless steel, hot-dip galvanized steel, or approved plastics; no unlined galvanized or copper-based material that reacts with foam concentrate), and avoid dead legs.

4. Install strainers, check valves, isolation valves with supervisory switches, pressure gauges and sampling points on solution and concentrate lines.
5. Install the foam pump and its controller, relief valve and a recirculation line where required; check rotation, alignment and seal.
6. Install tank fill connection, level indicator and air vent; label all valves and gauges.

14.3 Piping and Discharge Devices

1. Foam concentrate piping: stainless steel or other approved material, with welds free of internal debris, sized per calculation and installed with minimal change in direction.
2. Foam solution piping: black steel or galvanized steel, painted internally where specified, installed per Section 11, with drains at low points.
3. Install deluge valves with releasing trim and manual emergency release, and detection (heat/flame/UV-IR) per the design, interfaced with the FACP.
4. Foam chambers (Type II discharge outlets) and pourers installed on fixed-roof or floating-roof storage tanks as per NFPA 11, with vapour seal and frangible membrane; foam makers and expansion devices installed with correct orientation.
5. Foam-water sprinklers/nozzles and monitors installed per design spacing and orientation; aspirating and non-aspirating types are not interchanged.
6. High-expansion foam generators: installed in specified locations with air intake free from obstruction and contamination, and with ductwork supported.
7. Install foam hydrant or foam monitor connection points, foam-line wash and flush connections, and spill containment as required.

14.4 Electrical, Detection and Control

- Install and wire the detection panel, solenoid release devices, level switches and flow switches, with supervision and interlocks to the pump controller.
- Hazardous area equipment (Zone 1/2 or Class I Div 1/2) must have the correct certification (ATEX / IECEx / UL), installed to IEC 60079 / NFPA 70 Article 500 series.
- Cable glands, conduits and seals installed with approved certified items; earthing and bonding of tanks and pipework provided to avoid static accumulation.

15. Testing and Commissioning

All tests are carried out against approved test procedures, with calibrated instruments, after prior notice to the Client/Consultant/AHJ, and recorded on signed test certificates. Testing starts only after all work in the section under test is complete and inspected.

15.1 Common Pre-Test Requirements

1. Approved test procedure, RAMS and PTW in place; test boundaries defined on a marked-up drawing.
2. Gauges calibrated (certificate within 6 or 12 months, as specified), with range 1.5 to 2 times test pressure.
3. Components not designed for test pressure (sprinklers, pressure switches, fire pump casings, FM-200 heads, instruments) are isolated or not yet installed.
4. Water for testing and flushing is clean; discharge routes are agreed and protected so there is no damage or environmental impact.
5. Test area barricaded and signed; personnel are briefed and non-essential staff cleared.

15.2 Sprinkler System Tests

Test	Method	Acceptance Criteria	Reference
Underground flushing	Flow at not less than the system demand or maximum available until water is clear	Clear water; no debris at the discharge	NFPA 24 / NFPA 13
Underground hydrostatic	14 bar (200 psi) for 2 hours (or 3.4 bar above static where static exceeds 10.3 bar)	No visible leakage; leakage within the NFPA 24 allowance	NFPA 24
Aboveground flushing	Flush risers and mains with water at demand flow rate	Clean water	NFPA 13
Aboveground hydrostatic	14 bar (200 psi) for 2 hours, or 3.4 bar above working pressure where it exceeds 10.3 bar	No leakage at joints; no pressure drop	NFPA 13
Dry pipe air test	2.8 bar (40 psi) air for 24 hours	Loss not more than 0.1 bar (1.5 psi)	NFPA 13
Dry pipe trip test	Open inspector's test at remote point	Water delivered within the time allowed in NFPA 13 for the system	NFPA 13
Main drain test	Fully open the main drain on each riser with the control valve open; record static and residual pressure	Residual comparable to the hydraulic calculation and previous tests	NFPA 25 / NFPA 13
Alarm and flow switch test	Open inspector's test connection	Local gong and FACP alarm within 5 minutes of flow and at 90 seconds for supervising stations where specified	NFPA 13 / NFPA 72
Tamper switch test	Operate valve handwheel two turns	Supervisory signal at the FACP	NFPA 72
Fire pump acceptance	Churn, 100%, 150% flow at not less than 65% of rated pressure; automatic start on pressure drop; alternate source/manual start; diesel run for the specified period	Performance meets the manufacturer's certified curve (no less than 95% of rated), no overheating or abnormal vibration	NFPA 20
Jockey pump	Set pressure points	Starts and stops at the set points; no frequent cycling	NFPA 20
Hydrant and standpipe flow	Flow at the most remote hose connection	Required pressure and flow achieved	NFPA 14 / NFPA 24
Hydraulic verification	Compare field data with the hydraulic calculation	Field pressure at or above the calculated demand with margin	NFPA 13

Contractor's Material and Test Certificate (NFPA 13 form) for aboveground and underground piping is completed, signed and submitted for each test.

15.3 FM-200 System Tests

1. **Piping pneumatic test (leak/integrity):** After installation and before cylinder connection, isolate nozzles and cylinders; pressurise the pipe network with dry nitrogen or air to 2.8 bar (40 psi) for 10 minutes; allowable pressure loss not more than 20% of test pressure (NFPA 2001); where hydrostatic testing is

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required by the specification or the listing, test at 1.5 times the maximum working pressure and dry thoroughly.

2. **Pipe cleanliness and nozzle check:** Blow through the pipework with dry nitrogen or compressed air before the nozzles are installed; verify the nozzle size and orientation against the drawing.
3. **Enclosure integrity test (door fan test):** Carried out with a calibrated door fan under NFPA 2001 Annex / ISO 14520-1 Annex E procedures; software calculates the predicted hold time at the highest protected level; acceptance is the minimum hold time (10 minutes at 85% of design concentration or as specified). Where the test fails, locate leaks using smoke pencil or thermal imaging, seal, and retest; leakage sealing is by the Main Contractor/Fit-out.
4. **Detection and alarm test:** Test each detector (heat/smoke) with approved smoke or aerosol; cross-zone logic (first detector pre-alarm, second detector discharge countdown); abort and manual release functions; time delay; supervisory and trouble signals for open circuit, short, earth fault, and disconnected solenoid.
5. **Ancillary functions:** Verify HVAC shutdown, damper closure, door release, signal to main FACP/BMS, and power cut-off where specified; all done with the agent actuators disconnected and replaced with a test lamp or load simulator.
6. **Agent quantity verification:** Check cylinder pressure gauges and net weight (record agent weight and pressure at ambient temperature) against nameplates and calculation; confirm HFC-227ea certificate of conformity.
7. **Full discharge test:** A full-discharge test using actual agent is generally not required by NFPA 2001 and is not recommended because of cost and environmental impact; if requested by the Client or AHJ, it is carried out under a separate approved procedure with full safety measures and agent recovery. Instead, a “mock discharge” is simulated by electrical-only test with actuators disconnected.
8. **Final live connection:** After approval, connect the actuators, remove safety pins, restore the system to automatic mode, and the manufacturer’s representative certifies the system, issues a commissioning certificate and verifies the tamper-evident seals.

15.4 Foam System Tests

1. **Flushing and hydrostatic test:** Flush the water and solution piping before connecting the proportioner, then hydrostatic test at 14 bar (200 psi) for 2 hours, or 3.4 bar above maximum working pressure where this exceeds 10.3 bar (NFPA 16 / NFPA 13); foam concentrate piping tested at 1.5 times working pressure per specification, and flushed with water, then drained; the concentrate lines are not exposed to test water unless approved by the manufacturer.
2. **Proportioner calibration test:** With the discharge of foam solution collected, take samples and measure the concentration by refractometer, conductivity meter or the manufacturer’s method; acceptance is within -0% to +30% of the nominal concentration, or as the NFPA 11 / manufacturer allows (e.g., 3% proportioning measured between 3.0% and 3.9%).
3. **Operational flow test (water only where permitted):** Use water to confirm the flow rate, pressure, nozzle/discharge pattern and valve operation; where the full foam discharge is required, collect the runoff and manage it in compliance with Section 19.
4. **Foam quality test:** Measure expansion ratio and 25% drain time using foam samples collected from the discharge device; compare with manufacturer data and NFPA 11 Annex; for high-expansion systems, measure fill time and expansion at the generator.
5. **Deluge valve and detection test:** Test automatic release by simulating detector activation (heat or flame), manual release, valve reset, and pump auto start; verify alarm and signalling to the FACP.
6. **Foam concentrate analysis:** Take a sample of delivered concentrate, and send it to an accredited laboratory to confirm compliance with the listing before the system is accepted (NFPA 11 Chapter 11 on acceptance); after commissioning, annual sampling is done in the ITM period.
7. **Foam chamber and pourer test:** Confirm vapour seal rupture, foam flow to tank wall or surface, and use only a flow of water or a limited foam discharge approved by the Client.

15.5 Integrated System Test

When the individual system tests are accepted, an integrated test is carried out with the Client, Consultant, the Main Contractor's fire alarm and BMS teams, and the AHJ, covering:

- Fire alarm initiation of fire pump start, sprinkler flow, FM-200 release control, foam deluge release and HVAC shutdown.
- Signal transmission to the central monitoring station and the fire command centre.
- Power failure and restoration, standby power operation, and generator changeover.
- Simultaneous operation of systems to verify no interference with water supply and electrical load.

15.6 Acceptance and Certification

1. Contractor completes a self-inspection and snag list, closes all items, and submits records to the Consultant.
2. The Consultant/Client and AHJ inspect and witness acceptance tests; the AHJ certificate (Civil Defence approval) is obtained.
3. Manufacturer commissioning certificates for the fire pump, FM-200, foam and release panel are submitted.
4. Final Completion Certificate or Letter of No Objection is received before system handover.

16. Inspection and Test Plan (ITP)

H = Hold Point, W = Witness Point, R = Review, S = Surveillance. Acceptance criteria reference the approved specification and referenced standards.

No.	Activity	Reference	Contractor	Consultant	AHJ / 3rd Party	Record
1	Submittal and drawing approval	Spec, NFPA	H	H	R	Approved submittals
2	Material inspection (pipes, valves, sprinklers, cylinders, foam)	Approved MAR, UL/FM	H	W	–	MIR, delivery certificates
3	Underground pipe laying and thrust blocks	NFPA 24	H	W	–	WIR
4	Underground flushing and hydrostatic test	NFPA 24	H	W	W	Test certificate
5	Fire pump and tank installation	NFPA 20/22	H	W	–	WIR, alignment record
6	Pipe fabrication, supports and installation	NFPA 13	H	W	–	WIR
7	Welding inspection and NDT (if applicable)	ISO 5817 / ASME IX	H	W	–	Weld log
8	Aboveground flushing	NFPA 13	H	W	–	Flushing certificate
9	Aboveground hydrostatic test	NFPA 13	H	W	W	Contractor's test certificate
10	Sprinkler head installation	NFPA 13	H	S	–	WIR

No.	Activity	Reference	Contractor	Consultant	AHJ / 3rd Party	Record
11	FM-200 cylinder and piping installation	NFPA 2001	H	W	–	WIR, manufacturer checklist
12	FM-200 pipe pneumatic test	NFPA 2001	H	W	–	Test certificate
13	Enclosure integrity test	NFPA 2001 / ISO 14520	H	W	W	Door-fan report
14	Foam system installation	NFPA 11/16	H	W	–	WIR
15	Foam proportioning and discharge tests	NFPA 11/16	H	W	W	Foam test report
16	Fire pump acceptance test	NFPA 20	H	W	W	Pump test certificate
17	Detection and control interface test	NFPA 72 / ISO 7240	H	W	W	Loop test records
18	Integrated system test	Project spec	H	W	W	Integrated test report
19	Final inspection, snagging and AHJ acceptance	AHJ	H	H	H	Completion certificate
20	As-builts, O&M manuals, training	Spec	H	R	R	Handover dossier

17. Risk Assessment

Risk rating = Likelihood (1–5) × Severity (1–5), in line with ISO 45001 and ISO 31000. Residual risk must be Low or Medium (not exceeding 8) before work begins; any High risk requires management approval.

No.	Activity	Hazard	Initial Risk	Control Measures	Residual Risk
1	Material handling and unloading	Manual handling injury, falling loads, vehicle accidents	High	Mechanical aids, trained riggers, banksman, traffic plan, certified lifting gear	Low
2	Work at height (hangers, pipe, sprinklers)	Fall from height, falling objects	High	Inspected scaffold or MEWP, harness, exclusion zones, tool tethers, trained workers	Low
3	Welding and cutting	Fire, burns, fumes, eye injury	High	Hot work permit, fire watch, extinguishers, screens, PPE, ventilation	Low
4	Excavation for underground main	Collapse, utility strike, falls into trench	High	Permit, scan, shoring, barricades, ladders, supervision	Low

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No.	Activity	Hazard	Initial Risk	Control Measures	Residual Risk
5	Hydrostatic and pneumatic testing	Burst, whiplash, flying fittings, slips	High	Procedure, calibrated gauges, barricade, relief valve, bleed air, cleared area	Low
6	Pump and tank installation (lifting and confined space)	Crush, dropped load, oxygen deficiency	High	Lifting plan, confined space permit, gas test, standby person	Low
7	Electrical connections and testing	Electric shock, arc flash	High	Qualified electricians, LOTO, tagged tools, RCDs, insulated equipment	Low
8	FM-200 cylinder handling	Cylinder falling or rocketing, pressure release	High	Valve caps in place, trolleys, restraints, no connection of actuators until final stage, certified technicians	Low
9	Accidental agent discharge during commissioning	Asphyxiation concerns, decomposition products, noise, cold	High	Actuators disconnected, safety pins, system locked off, room evacuation procedures, pre-discharge alarm test	Low
10	Foam concentrate handling and testing	Skin and eye irritation, slips, environmental contamination	Medium	SDS, PPE, bunding, spill kits, containment of run-off, licensed disposal	Low
11	Flushing and drain discharge	Flooding, slips, damage to finishes and equipment	Medium	Hoses secured, defined drain route, water barriers, monitoring	Low
12	Heat stress (outdoor and hot work)	Heat exhaustion, dehydration	High	Rest breaks, shade, water, acclimatisation, work-hour limits, supervision	Medium
13	Noise and dust (cutting, drilling, grinding)	Hearing loss, respiratory irritation	Medium	PPE, wet cutting, dust extraction, screens	Low
14	Interface with live systems	Accidental trip of building systems, false alarms	Medium	Coordination with FM team, impairment procedure, notification, fire watch	Low

18. Permit to Work and Control of Hazardous Activities

Permit Type	When Required	Key Conditions
General Work Permit	All construction activity under the site system	Approved RAMS; valid induction; supervisor on site
Hot Work Permit	Welding, cutting, grinding, brazing	NFPA 51B controls; fire watch for at least 30 minutes after the work; extinguisher and combustible clearance
Work at Height Permit	Work above the local height threshold	Inspected equipment; harness; rescue plan
Excavation Permit	Any digging	Service scan; shoring; barricades; daily inspection
Confined Space Entry Permit	Tanks, pits, valve chambers	Gas test; ventilation; standby; rescue
Electrical / LOTO Permit	Isolation of electrical equipment	Isolation, lock, tag, verify dead
Lifting Permit	Cranes, heavy lifts	Lifting plan; certified equipment and operator
System Impairment Permit	Any work that takes fire protection out of service (existing or adjacent buildings)	Client approval; notification of the fire brigade and monitoring station; fire watch; restoration and test (NFPA 25 Ch. 15)
Pressure Test Permit	Hydrostatic/pneumatic tests	Approved procedure; calibrated gauges; barricade
Gas System Isolation Permit	Testing of FM-200 and detection	Actuators disconnected; the control room informed; the system re-armed under sign-off

19. Environmental Management

Work complies with ISO 14001, the project Environmental Management Plan and local environmental regulations.

1. **Waste:** Segregate construction waste (metal, plastic, packaging, general); recycle scrap steel and pipe offcuts; transport waste only by licensed carriers and keep waste transfer records.
2. **Water discharge:** Flushing and test water are discharged to approved drains or retention areas after checking for contamination; discharge of water with chemicals or foam is not allowed in storm drains; treated or tankered away by a licensed contractor.
3. **Foam:** Foam concentration and foam solution are treated as hazardous or controlled waste; tests are limited, and run-off is contained with bunds and drain covers and removed by a licensed contractor; PFAS-containing foam is handled to the strictest local requirements.
4. **FM-200 and refrigerant handling:** HFC-227ea is a greenhouse gas; no venting of agent; use recovery equipment for any servicing; keep records of the agent weight and handling; follow local F-gas and Montreal/Kigali-related regulations where applicable.
5. **Spills:** Spill kits available at storage areas, with trained people; contaminated soil and absorbents are disposed of as hazardous waste.
6. **Noise, dust and emissions:** Limit noisy work to approved hours; use dust suppression; maintain equipment to reduce emissions; no burning of waste.
7. **Energy and water conservation:** Reuse test water where possible; switch off idle equipment.

20. Emergency Preparedness and Response

- The site emergency response plan, assembly points and emergency contacts are displayed and covered in induction.
- **Fire:** Raise the alarm, evacuate, and use extinguishers only if safe and trained; account for personnel at the assembly point; do not re-enter until cleared.
- **Injury:** Administer first aid by trained first aiders; call emergency services; protect the scene; report to HSE immediately and carry out investigation.
- **Accidental FM-200 discharge:** Evacuate immediately by the nearest exit, do not re-enter until the room is ventilated and declared safe; keep the exit signs and doors unobstructed; inform HSE and the Client; take exposed people to fresh air and seek medical attention if symptoms appear.
- **Chemical or foam spill:** Stop the source if safe, contain with absorbents and bunds, prevent entry to drains, notify HSE, and dispose of waste as controlled waste.
- **Excavation collapse or confined space emergency:** Do not enter to attempt a rescue without breathing apparatus and trained rescue team; activate the rescue plan.
- **Pressure test failure:** Stop pumping, release pressure safely, evacuate the barricaded area, and inspect only after pressure has been confirmed as zero.
- Emergency drills are performed as per the site plan, and the outcomes are recorded.

21. Handover, Training and Documentation

21.1 Handover Dossier

- As-built drawings (hard and soft copy, CAD/PDF/BIM) including piping, zones, isolating valves and detector layouts.
- Final hydraulic calculations, FM-200 flow calculations and foam calculations, updated to match as-built.
- Test and commissioning certificates: flushing, hydrostatic, pneumatic, enclosure integrity, pump, foam detection and integrated test.
- NFPA 13 Contractor’s Material and Test Certificates, and manufacturer commissioning certificates.
- Approved material submittals, listings (UL/FM/LPCB), warranty documents and spare parts list.
- Operation and Maintenance manuals, including the NFPA 25 and NFPA 2001 ITM schedules, system shutdown/restoration procedures and valve schedules.
- Authority approvals (Civil Defence completion certificate) and the insurer’s acceptance where applicable.
- Safety Data Sheets for the FM-200 agent and foam concentrate; list of the system signage.
- Spare sprinklers, tools, and keys; red-tag and impairment procedure.

21.2 Training

1. Training for the Client’s operation and maintenance staff on system operation, controls, alarm response, isolation and restoration, and reset.
2. FM-200 safety training: pre-discharge procedure, abort and manual release, evacuation, and post-discharge actions.
3. Pump, jockey and controller operation; weekly churn test procedure.
4. Foam system operation, refilling and sampling procedure.
5. Attendance records and training certificates are submitted.

21.3 Warranty and Defects Liability

The contractor provides the warranty and defects liability period of [12–24] months from the date of handover, or as stated in the contract, covering workmanship and materials, with a prompt response to defects.

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22. Post-Handover Inspection, Testing and Maintenance (ITM)

The Client shall arrange an ITM programme in accordance with the following, as a minimum:

System	Frequency (minimum)	Activity	Reference
Sprinkler control valves	Weekly / monthly	Visual check that valves are open and secured, with supervised valves checked	NFPA 25
Gauges and alarm devices	Quarterly / annually	Inspection, test and calibration	NFPA 25
Main drain test	Annually (and after valve work)	Compare residual to the previous results	NFPA 25
Fire pump (electric)	Weekly churn test (10 min), annual flow test	Run, record and compare to the original curve	NFPA 25 / NFPA 20
Fire pump (diesel)	Weekly (30 min) churn run, annual flow test	Check fuel, oil, battery and cooling	NFPA 25
Water tank	Monthly / annually	Level, condition, and internal inspection every 3–5 years	NFPA 25 / NFPA 22
Sprinkler heads	Annually inspection; sample testing at 50 years (standard response), earlier if corrosive	Check for damage, corrosion and obstructions	NFPA 25
FM-200 containers	Semi-annually check of pressure and weight; hydrostatic retest every 10 years (or per DOT / local rule)	Verify agent quantity (a loss of more than 5% weight or 10% pressure requires refilling)	NFPA 2001
FM-200 enclosure	Annually and after any modification	Door fan integrity test, damper and door operation check	NFPA 2001 / ISO 14520
FM-200 detection and control	Semi-annually	Functional test of detectors, panel, sounders, abort and manual release	NFPA 72 / NFPA 2001
Foam concentrate	Annually	Laboratory sample analysis and tank inspection	NFPA 11 / NFPA 25
Foam proportioning system	Annually	Proportioning accuracy test and flow test	NFPA 25
Deluge / pre-action valves	Quarterly / annually	Trip test and full flow test	NFPA 25
Signs and labels	Annually	Inspection of signs and identification	NFPA 25 / ISO 7010

All impairments follow the Impairment Program (NFPA 25 Chapter 15) with notification, fire watch and restoration.

HSE DOCUMENTS
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23. Appendices (Checklists, Forms and Records)

Appendix A – Material Inspection Request (MIR) Checklist

Item	Check	Result (Y/N)
Item matches the approved submittal, make and model		
UL/FM/LPCB listing and test certificates provided		
Quantity delivered correct, no damage or corrosion		
Pipe ends capped and clean, correct schedule and grade		
Sprinklers: type, K-factor, temperature rating and finish correct		
FM-200 cylinders: pressure, weight, nameplate, hydrostatic test date		
Foam concentrate: type, batch number, expiry and SDS		
Storage arrangement suitable and protected		

Appendix B – Hydrostatic Test Record

Field	Entry
System / zone tested	
Test boundary (drawing ref.)	
Test pressure and duration	
Start time / pressure	
End time / pressure	
Gauge number and calibration date	
Leakage observed (Y/N)	
Result (Pass/Fail)	
Witnessed by (Contractor / Consultant / AHJ)	

Appendix C – FM-200 Commissioning Checklist

Item	Status
Room volume, openings and temperature as per design	
Enclosure integrity test completed and hold time verified	
HVAC dampers and fans interlocked	
Pipe pneumatic test completed (40 psi, 10 min, loss 20% or less)	
Nozzle type, orifice and position as per calculation	
Agent quantity and cylinder pressure verified	

Item	Status
Detection cross-zoning, pre-alarm and delay time tested	
Manual release and abort tested	
Signage, strobe and sounder tested	
Actuators connected and system set to automatic after approval	
Manufacturer commissioning certificate issued	

Appendix D – Foam System Commissioning Checklist

Item	Status
Foam type and listing match hazard and equipment	
Proportioner installed and calibrated	
Concentrate quantity as per calculation	
Flushing and hydrostatic tests completed	
Discharge pattern, flow and pressure verified	
Expansion and drain time results recorded	
Deluge valve and detection tested	
Bunds and run-off containment in place	
Sample analysis certificate received	

Appendix E – Fire Pump Acceptance Test Record

Test Point	Flow	Pressure	Speed (rpm)	Amps / Engine Data	Result
Churn (shut-off)	0%				
Rated	100%				
Peak	150%				
Automatic start (pressure drop)					
Alternate source / manual start					

Appendix F – Project Contact and Emergency List

Role	Name	Mobile	Notes
Project Manager			
HSE Manager			
QA/QC Manager			
Client Representative			
Civil Defence / AHJ			
Ambulance / Fire / Police	[local emergency numbers]		

Appendix G – Method Statement Acknowledgement

All personnel involved in the work have read and understood this Method Statement, Risk Assessment and permit requirements.

Name	Position	Company	Signature	Date

Approval and Sign-Off

Role	Name	Signature	Date
Prepared by (Project Engineer)			
Reviewed by (QA/QC Manager)			
Reviewed by (HSE Manager)			
Approved by (Project Manager)			
Accepted by (Consultant / Client)			