

**Plan Review and Construction Project Guidelines
for
Columbia University & CUMC
NYC**



Prepared by
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Introduction

This document was prepared by FM Global to assist Columbia University and Medical Center in coordinating their construction and development projects. The information provided here is intended to provide only general project guidelines, as each project may have unique characteristics that fall outside, require less involvement from FM Global, or exceed the scope of this document. Therefore, it is always best practice to involve FM Global as soon as possible in the project development stages.

The first section of this document provides information for Columbia University and Medical Center to reference internally, as to the purpose, scope, and benefits of utilizing the FM Global Plan Review Department.

The second and third sections of this document serve to provide information to outside contractors and subcontractors to coordinate the review of project plans, provide general construction safeguards during projects, and outline FM Global's general involvement in Columbia University and Medical Center projects.

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Section I

PURPOSE

FM Global provides plan review and new project consulting services exclusively to our clients. These services are designed to assist in managing planned changes to our client's properties to ensure that losses are not incurred during development projects and that the final product is adequately protected, inherently safe, and not unacceptably exposed to any naturally occurring hazards.

GENERAL GUIDELINES

What projects should involve FM Global?

Any project that results in a change to automatic protection systems, occupancy, water supply or construction (including new construction, additions, and renovations) should be coordinated with FM Global. If there is question as to whether a project should involve FM Global, contact the FM Global Plan Review Department or your local servicing FM Global Consultant Engineer.

At what point should FM Global be involved with the changes?

FM Global should become involved as early as possible in the development stages of a project. This will allow us to identify loss prevention concerns at the beginning of a project so that agreed upon recommendations are incorporated into the initial design, budget, and cost estimates.

What can be done to ensure outside vendors follow Factory Mutual Research guidelines?

First, in the specifications for a new project, it should be stated and agreed upon that the design will meet Factory Mutual Research guidelines and, as applicable, utilize Factory Mutual Research Approved products. Second, contractors should be required to submit plans to the FM Global Plan Review Department and receive written acceptance prior to starting any work. Contractors should be made aware that the review process can take up to two weeks, with additional time required for changes if a submittal is found unacceptable. Section II of this document is intended to provide contractors with the guidance needed to meet the agreed upon standards of FM Global and Columbia University and Medical Center. However, as previously stated, the guidelines presented are general requirements and adherence does not guarantee approval by the Plan Review Department.

Generally, what prints will FM Global need to see?

The review requirements for each project will vary based on the size and scope of the project. However, in general the following are typical plans that FM Global would review:

1. Structural (Roof, Damage Limiting Construction, Fire Wall)

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2. Roof Covering
3. Site Plans for new buildings or additions
4. Architectural Drawings
5. Sprinkler Drawings
6. Alarm System Layout and Wiring
7. Special Protection Systems (CO₂, Halon, Dry Chemical)
8. Fuel Fired Equipment (Boilers, Ovens, Furnaces)
9. Process Equipment
10. Electrical Power Distribution

Other services provided by FM Global to help manage changes:

FM Global consultants conduct site surveys at potential locations for new facilities and existing facilities to test water supplies, identify possible external exposures, or evaluate fire protection systems or construction features.

During a project, special visits are conducted to monitor the status of construction and to ensure that accepted designs are being installed in accordance with the reviewed plans. General safeguards during construction such as the control of combustible material, supervision of ignition sources, and proper handling of fire protection impairments are monitored. FM Global consultants will also act as a resource for the contractors to make sure that they fully understand the requests and recommendations made by FM Global.

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Section II

GENERAL PLAN SUBMITTAL INFORMATION

Please submit requested plans and documents to:

Attention: Plan Review Department

FM Global
300 Kimball Drive
Suite 200
Parsippany, New Jersey 07054
United States

Phone: 973-541-6993/6994

Email: ENGNewYorkPlanReview@fmglobal.com

Plan Submission:

Please submit plans/documents via electronic means (e.g. email, hosted FTP, Dropbox). Hard copy submissions are also acceptable. Plans will be reviewed with comments provided within approximately two weeks.

Review Letter Distribution:

Please include a list of contact persons that should receive plan review correspondence via email.

Re-submittals of rejected plans will generally take less than 14 days, contingent upon the timely receipt of requested information and satisfactory updates/changes to the original submittal. Plans should be submitted early enough that requested changes can be made or additional information attained, prior to beginning a project, if required based on FM Global's review.

CONSTRUCTION PROJECTS

New Construction and Additions

Construction Project General Guidelines

The following design criteria should be used:

Columbia University and Medical Center

Rainfall Intensity: 8 in/24 hr
Ground Snow Loading: 30 psf
Wind Zone: 105 mph

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Ground Roughness Coefficient: B (some C due to height)

Construction Project Submittals

Construction project submittals, for new construction or additions, should consist of the following:

1. Site Plans - Include finished floor elevations, finished grading elevations and details on additions and modifications to the yard mains, control valves and fire hydrants.
2. Construction Drawings- Include basic construction details, finished roof elevations of both new and any adjacent, existing buildings, insulation and finishing materials details, roof loading design criteria, etc. For "pre-engineered" metal buildings, complete construction drawings and roof load calculations are required.
3. Specific Exposures - For areas requiring specialized construction, technically complete drawings and calculations should be submitted. For example, damage-limiting construction for occupancies with explosion potentials (flammable liquids handling, ammonia compressor rooms, etc.) or roof areas with unbalanced snow load potentials (snowdrifts).

ROOFING/RECOVER PROJECTS

Roof assemblies are designed to protect the building, its contents, and its occupancy from expected hazards resulting from fire, wind, weathering, and other perils for an extended number of years. Roof covers must be designed to protect the underlying components that make up the roof assembly itself, including the covering, fasteners, insulation, deck and structural substrate. FM Approved roof constructions have been evaluated and proven to reduce or minimize loss potential resulting from these hazards.

General Roof Deck and Above Deck Assembly Guidelines

When

1. An FM Approved non-combustible or Class 1 fire rated roof assembly should be chosen and listed in FM Approval's RoofNav www.roofnav.com system. The windstorm rating and design uplift pressures should be based on the criteria provided in construction guidelines and incorporate a building importance factor of 1.15.
2. If within the scope of the project, an FM Approved roof deck and Approved side lap fasteners should be used.
3. All buildings should be designed using a minimum balanced ground snow load as listed in construction guidelines. Despite the allowances made by local codes, this ground snow load should not be reduced by more than 10%. Increased loading due to elevation changes must be considered in the design calculations.

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4. Building roof drains should be capable of removing at least 3.25 inches per hour of rainfall from the roof. The roof framing system should be able to support the maximum build-up of water that could accumulate if the primary drainage system is blocked. In other words, the roof strength needs to sufficiently withstand the weight of retained water that cannot be handled by normal drainage until the emergency drainage comes into play.
5. A copy of the FM Global Form 2688 “Contractor’s Application for Acceptance of Roofing System” should be submitted along with any roofing submittal.

New Roof Plan Submittals

New roofing plan submittals should, at minimum, consist of the following items:

1. Structural Prints - These should include information detailing roof installation, flashing installation, and roof loading design (both live and dead load).
2. Roof Drainage System - Drawings should clearly indicate drain sizes, locations with respect to building columns, and the number of drains to be installed for both primary and emergency drainage. It is recommended that roof drainage calculations are included in the plans.
3. Snow Loading Calculations - When applicable, these should be submitted to ensure that the average snow load due to an unbalanced snow load does not exceed the design live load of the roof.
4. Wind Uplift Rating - The uplift rating of the roofing system should be specified to ensure that it is properly designed to withstand the anticipated uplift pressures.
5. Specific Flashing Details
6. Roof Specifications for:
 - a. Materials (manufacturers, model and size for insulation boards, vapor barriers, adhesives, membranes and any other component of the system).
 - b. Fastening (manufacturer’s name, model, and proposed fastening rate/density).
 - c. Roofing System including the RoofNav number.

While roofing components are individually FM Approved (i.e. roofing adhesives, insulations, fasteners, etc.); a roofing system must be approved as an assembly. These various assemblies which have been satisfactorily tested are given a RoofNav Assembly Number.

Re-roof and Re-cover Projects

Submittals for re-roof and re-cover projects should include the information listed above, as applicable. However, in many cases drainage calculations and structural plans will fall outside the scope of a re-roof or re-cover project. If the new roof assembly differs from the original assembly, it should be verified that the building design loads are not exceeded.

Re-roof and re-cover projects should adhere to the general roofing guidelines listed above and consist of a non-combustible or Class 1 rated assembly, approved by FM for the specific application (i.e. re-cover or re-roof).

AUTOMATIC SPRINKLER PROTECTION

General Automatic Sprinkler Protection System Guidelines

1. All sprinklers, valves, devices, and fittings should be FM Approved.
2. A 10 psi safety factor should be included in sprinkler system hydraulic calculations to accommodate for any future deterioration or fluctuations in the public water system.
3. All sprinkler heads should be installed using the appropriate wrench as specified by the sprinkler manufacturer. This will help to ensure that the heads are installed properly without damage.
4. All sprinkler piping should be hydrostatically tested at 200 psi, or 50 psi above the highest working pressure, and should maintain that pressure without loss for 2 hours. Pressure loss should be determined by drop in gauge pressure or visual leakage.
5. The FM Global Red Tag Permit System should be utilized to supervise any valve closures during this installation.
6. Recommended sprinkler system design criteria for typical areas that will be encountered are listed in Table 1 of the Appendix. For any occupancy that does not exactly match that in the table or for guidance on determining what design to use from the table, contact the FM Global Plan Review Department or your FM Global servicing engineer. The densities in the table are presented only as guidelines; other factors may affect the recommended design criteria.

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7. For new installations of wet-pipe sprinkler systems, use FM Approved standard or quick-response, standard-coverage or extended-coverage, non-storage automatic sprinklers with a temperature rating of 160°F (70°C). Sprinklers with a temperature rating of 212°F (100°C) may be used in locations where the ambient temperature is in excess of 110°F (43°C). For locations prone to extremely cold and freezing conditions, use dry-pipe sprinkler systems with upright, standard response, standard-coverage sprinklers with a temperature rating of 280°F (140°C).
8. Where existing buildings are being provided with automatic sprinkler protection, FM Approved sprinklers should be utilized where possible. When utilizing concealed horizontal sidewall heads, there are no final FM Approved installation options. There are several horizontal sidewall sprinkler heads with a “K” factor of 8.0 that are FM Approved as recessed heads and also have the concealment option. The FM Approved sprinkler head is no longer considered Approved when fitted with the concealment cover, but this arrangement is considered acceptable. In addition, FM Approved heads exist which can be field fitted with an inner plate to receive the concealment dome. As previously stated, the final installation will not be an FM Approved arrangement, but it is considered acceptable given that the actual sprinkler head will be an FM Approved product.
9. Final acceptance will be upon completion of the Contractor’s Material and Test Certificate (Form 85A) and field examination by an FM Global representative. See Appendix.

Automatic Sprinkler Protection Submittals

Automatic sprinkler protection plan submittals should consist of the following items:

1. Fire Protection Drawings of the proposed system(s). At minimum, submitted fire protection drawings should include:
 - a. Piping layout and sizes.
 - b. Location and number of sprinklers (with sprinkler identification numbers (SIN) clearly indicated on the drawing).
 - c. Location of remote area used in hydraulic calculations.
2. Hydraulic Calculations.
3. Specifications for materials being used, including but not limited to:
 - a. Sprinkler heads
 - b. Sprinkler pipe
 - c. Sprinkler control valves
 - d. Any peripheral equipment - including tamper alarms, waterflow alarms, etc.

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4. Occupancy Details - In order to review submitted plans to ensure adequate protection, accurate occupancy details must be provided. This would include a general description of the area being protected and, in the case of dedicated storage areas details of the materials being stored, storage height, storage arrangement, etc. should be provided.

FIRE PROTECTION WATER SUPPLY – UNDERGROUND MAINS

General Water Supply Guidelines

1. Local governing authorities may require the installation of various system components. Use Factory Mutual Research Approved components. Components should be made in accordance to American Water Works Association (AWWA) or to similarly recognized standards.
2. Hydrostatically test all new yard piping at not less than 200 psi pressure for two hours or at 50 psi over the maximum static pressure when the maximum static pressure is above 150 psi. If a booster pump is present, consider the pump shut-off (churn) pressure in determining the maximum static pressure.
3. Final acceptance will be upon completion of Contractor's Material & Test Certificate for Underground Piping Form-85B. See Appendix.

Submittals for: Water Supply, Underground Mains, Associated Appurtenances

Submittals for water supply piping installations should, at minimum, include the following items:

1. Complete set of manufacturer's specification sheets for all components.
2. Detailed drawings indicating the location (relative to proposed or existing buildings), depth, and sizing of all system components.
3. Sizing for thrust blocks or other pipe restraint devices.

FIRE PUMP/BOOSTER PUMP INSTALLATIONS

General Fire Pump/Booster Pump Guidelines

1. The fire pump/booster pump and all associated, applicable components should be FM Approved.
2. Where the supply for a fire booster pump takes suction from a public main, the pump should not draw the public supply below 20 psi when operating at 150% rated capacity.

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3. Where the suction supply is of sufficient pressure to be of material value without the pump, the pump shall be installed with a by-pass.
4. A listed outside screw and yoke (OS&Y) shall be installed in the suction pipe. No valve other than an OS&Y valve should be installed in the suction pipe within 50 ft of the pump suction flange.
5. The pump arrangement should be designed such that, when the pump is operating at 150% of rated capacity, the velocity in the portion of pipe located within 10 pipe diameters upstream of the suction flange does not exceed 15 ft/sec.
6. The performance of all fire pumps and booster pumps should be automatically indicated on a pressure recorder having either reliable electric drive or mechanical spring driven drive.
7. A separate controller and pressure sensing line should be provided for each pump, including the jockey pump. In general, the pressure sensing line should be arranged as follows:
 - a. The line should be of the ½ in. nominal size made of either copper or brass. There shall be two check valves installed in the pressure sensing line at least 5 ft apart with a 3/32 in. hole drilled in the clapper to serve as dampening.
 - b. There should be no shut-off in the pressure sensing line.
8. The fire pump system, with start by pressure drop, should be arranged as follows:
 - a. The jockey pump start point should be 5psi above the pump churn pressure plus maximum city static supply pressure.
 - b. The jockey pump stop point should be 10 psi above the jockey pump start point.
 - c. The fire pump start point should be 5-10 psi less than the jockey pump start point.
9. The fire pump should be arranged for manual stopping only. An automatic run-timer should not be used.
10. The coupling on the fire pump should be a coupling that does not rely solely on an elastomeric (plastic) material for power transmission. An FM Approved drive coupling should be provided.
11. All sprinkler piping should be hydrostatically tested at 200 psi, or 50 psi above the highest working pressure, and should maintain that pressure without loss for 2 hours. Pressure loss should be determined by drop in gauge pressure or visual leakage.

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12. The FM Global Red Tag Permit System should be utilized to supervise any valve closures during the pump installation.
13. Final acceptance of the pump installation will be upon satisfactory field examination by an FM Global representative. Sufficient time should be provided between notification and the test so that necessary information can be provided to the FM Global representative. The pump manufacturer, the driver manufacturer, the controller manufacturer, or their respective representatives, as well as any authorities having jurisdiction, shall be present for the field acceptance test.
14. FM Global Form 105B "Pump Acceptance Test Data" should be completed and submitted to FM Global following acceptance/commissioning testing.

Fire Pump/Booster Pump Submittals

All fire pump and booster pump submittals should, at minimum, include the following items and information:

1. Fire Protection Drawings of the proposed system(s).
2. Manufacturer's specification for the fire pump, driver, controller, etc.
3. Manufacturer's specifications for all materials and peripherals.
4. Manufacturer's certified bench curve for the pump (pump curve).
5. Pump House design and layout information (including location and construction).
6. Single line diagram showing the electric feed arrangement (for Electric pumps).

ALARM SYSTEMS

Alarm System Submittals

Alarm system submittals should, at minimum, include the following

1. Manufacturer's name and model number(s) for the entire system or system component/options.
2. Manufacturer's specification sheets for all equipment/components.
3. Drawings showing system component layout, panel wiring, battery backup (if applicable).

SPECIAL PROTECTION SYSTEMS

Special Protection System Submittals

Alarm system submittals should, at minimum, include the following:

1. Drawings of the system.

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2. Calculations showing required concentrations/densities and durations available from the special protection system.
3. Manufacturer's equipment specifications.
4. Occupancy details.
5. Satisfactory completion and submittal of FM Global Form 2332 "Contractor's Application for Acceptance of Gas System" for the specific special protection system.

BOILER AND GENERATOR FUEL SYSTEMS

General Guide for New Boilers and Fuel System Installations

Guidance provided below for a new generator fuel system and piping should be applied to a fuel oil fired boiler. In general, the guidance for the generator room arrangements should be applied to the installation of a new boiler. Given the inherent differences between boiler systems and generators, several of the items discussed below for generators will not apply to boilers.

General Guide for Boiler and Pressure Vessel Plan Submittals

Boiler and pressure vessel submittals should, at minimum, include the following:

1. Drawings showing location and layout
2. Specification of protection devices
3. Manufacturer details and specifications (including identification numbers) for all equipment.

General Guide for New Emergency Generator and Fuel System Installations

It is the best advice of FM Global to locate emergency generators and fuel tanks outside of the building. However, if a generator or tank must be located indoors or on a roof top, FM Global offers the following recommendations.

Main Tank Rooms

1. Provide one of the following
 - a. A 3 hour fire rated concrete or a 3 hour rated fire resistive covering specifically designed for a hydrocarbon fire exposure on any exposed steel in the tank room/vault, pump room/vault, and generator or fuel oil fired boiler room.
 - b. A 3 hour fire rated enclosure for the tank room/vault, pump room/vault, and generator or fuel oil fired boiler room. Use concrete or masonry walls for the enclosures.

Note: Design the tank room or vault, regardless of location, to contain the entire content of the fuel tank(s) plus a minimum of a 2 in. freeboard through

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the use of curbs or dikes. Ensure floors are liquid tight. Ensure walls are liquid tight for the height of the curb or dike.

For the main tank room, the following items should be provided:

- c. Provide an emergency drainage system in the tank room/vault or provide a special protection system.
- d. Arrange fuel tanks to be filled via a hard piped system that terminates outside the building.
- e. Provide overflow protection for the tank via a high liquid level device.
- f. Ensure the breather vent is hard piped to a safe location outside the building.
- g. Provide a properly sized emergency relief vent hard piped to a safe location outside the building.
- h. Arrange the discharge line for the tank to exit the top of the tank. For tanks with bottom discharge lines, provide a fusible link operated safety shut-off-valve (SSOV) at the tank outlet.
- i. Provide automatic sprinkler protection in the tank room/vault designed to provide a density of 0.30 gpm/ft² over the tank room/vault area.
- j. Arrange tank filling operations to be automatically shut down upon detection of any of the following:
 - i. High liquid level in the tank
 - ii. A liquid spill in the tank room/vault
 - iii. A fire in the tank room/vault

Shut-down should be accomplished via an automatically operating safety shut-off valve. Locate the safety shut-off valve as close to the tanker truck connection point as possible.

Fuel Pumping and Transfer Piping System

- 1. Isolate fuel pumps located inside buildings, at grade level, as follows:
 - a. Provide a cut-off room with a minimum fire rating of 1 hour and locate the room along an outside wall with openings accessible to firefighters. Pumps may be located in the main fuel tank room.
 - b. Provide a minimum 4 in. curb across all door openings of the pump room
 - c. Ensure that all floors and wall are liquid tight.
- 2. Isolate fuel pumps located inside buildings, either above or below grade level, as follows:
 - a. Provide a concrete or masonry vault. Design the vault to contain the entire contents of the fuel tank plus a minimum of a 2 in. freeboard through the use of curbs and dikes. Provide an emergency drainage system in the pump room or vault or provide a special protection system.

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- b. As an option, pumps may be located in a properly arranged and protected main fuel tank vault.
- 3. Arrange and protect fuel pumps located inside buildings as follows:
 - a. Provide positive displacement pumps sized to provide the needed flow rate.
 - b. Arrange the pump to take suction from the top of the fuel tank. Elevate the pumps to the same elevation as the top of the fuel tank or provide an anti-siphon device. Locate the anti-siphon device as close to the tank outlet as possible. If a pump is arranged to take suction from the bottom of a tank and the pump is located in a separate room/vault from the tank, provide a safety shut off valve that can be interlocked to shut down in the event of a leak or fire at the point of pipe entry into the pump room/vault.
 - c. Provide a pressure relief valve down stream of the positive displacement pump and pipe back to tank.
 - d. Provide automatic sprinkler protection in the pump rooms/vaults designed to deliver a density of 0.30 gpm/ft² (10 mm/min) over the tank room area. Extend a sprinkler down from the ceiling to within 2 ft. (0.6 m) of the pumps.
- 4. Arrange piping located inside buildings that is concealed or in non-manufacturing occupancies as follows:
 - a. Provide welded, double-wall, steel pipe and fittings in all areas outside the tank room, pump room and generator/fuel fired boiler room. An acceptable alternative is to locate single-wall piping in sealed pipe chases/shafts with at least a 2 hour fire rating.
- 5. Protect and arrange fuel distribution systems located inside important buildings as follows:
 - a. Arrange the fuel distribution system to automatically shut down the flow of fuel in the event of a fire or detected leak that involves or exposes the tank room, pump room, generator room or fuel piping anywhere along its path through the building. At a minimum, install and arrange safety shut-off valves or positive displacement pumps to isolate all fuel tanks, including day tanks, pipe headers and tanker trucks. Use of a fusible link operated valve is an acceptable way to shut-off discharge line(s) from day tanks or pipe headers, up to 660 gal in size, located in the generator room.
 - b. Arrange pumps to operate on fuel demand (i.e. low day tank level **PLUS** generator operation). This arrangement may require that pumps be arranged to run manually to top-off tanks after engine tests. Arrange manual pump operation via a dead-man type switch. This recommendation does not apply to fuel fired boilers, as there are no day tanks involved.
 - c. Provide a manual remote shut-off for the fuel pumps and safety shut-off valves in a readily accessible location under fire

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conditions (e.g., outside pump, tank or generator rooms and at the main alarm panel).

Generator and Fuel Oil Fired Boiler Rooms

1. Generators and boilers utilizing fuel oil located inside buildings should be isolated as follows:
 - a. Provide fire rated construction to isolate generators that are located either above or below grade level with a concrete or masonry vault or provide a 3 hour fire rated cut-off room. Exterior walls do not need to be fire rated.
 - b. For roof mounted generators and boilers, the room should not expose any other building areas. The generator room should be of non-combustible construction with containment provided as described below.
 - c. For generators and fuel oil fired boilers that are located at grade level, provide a cut-off room with a minimum fire rating of 1 hour and locate the room along an outside wall with openings accessible to firefighters.
2. In addition to fire resistive construction:
 - a. Design the generator or fuel fired boiler room/vault, regardless of location, to contain the entire content of all fuel tank(s) located in the room plus a minimum of a 2 in. freeboard through the use of curbs or dikes (minimum curb height of 4 in).
 - b. Provide liquid tight floors and walls to the height of the curb.
 - c. Provide an emergency drainage system in the generator or fuel oil fired boiler room. Alternatively, provide a special protection system in the room.
 - d. Arrange the cut-off room to provide ventilation and room exhaust from/to areas outside the main building.
 - e. Fuel headers are not recommended for new construction.
 - f. Provide a dike around day tanks designed to contain the entire contents of the tank plus 2 in. freeboard.
 - g. Limit the total capacity of day tanks or pipe headers within a fire compartment to a maximum of 660 gal.
 - h. Ensure all day tank breather vents are piped to a safe location outside the building.
 - i. Provide automatic sprinkler protection in the generator or fuel oil fired boiler room designed to deliver a density of 0.30 gpm/sq. ft. over 4000 ft. (286°F sprinklers) or 6000 ft. (165°F sprinklers) plus 500 gpm for hose streams.

SECTION III

SAFEGUARDS DURING CONSTRUCTION

Background

The danger of a potential fire is usually much greater while a building is being constructed, altered or demolished than after work is completed and the fire protection equipment is in service. As work progresses, accumulations of combustible building materials, wooden forms and scaffolding, scrap lumber, paper and plastic packing and wrappings, and other refuse appear at new locations daily. The fire danger is increased further by the presence of many ignition sources, such as hot work equipment, carelessly discarded matches or cigarettes; temporary heaters and lights; and roofers' tar kettles, heating guns and torches.

Many serious fires have occurred during the construction period, destroying valuable property and delaying completion of a project. Close follow-up throughout the construction period is required to assure that safeguards are put into practice and are strictly enforced by the contractor.

Construction and Location

1. Temporary trailers, sheds or offices should be of noncombustible construction when located within or near the building being constructed or renovated. When the temporary structure or its contents are combustible, locate the structure at least 50 ft away from main buildings and at least 30 ft apart from each other, or protect with automatic sprinklers.
2. Install only as much roof insulation as can be covered with roof covering in a single working day, or prior to the expected start of inclement weather. Seal loose roof cover edges at the end of each day to minimize potential moisture damage. Asphalt or coal tar (as appropriate) can be used for built-up roof (BUR) covers; proprietary sealers are available for single-ply roof covers. Do not allow water to run in the deck ribs under completed roof sections. Follow manufacturer's recommendations.
3. Whenever a chute is to be utilized for debris removal, install it on the outside of the building. Its construction should be noncombustible. The main artery of the chute should be as straight as possible to help prevent accumulations or clogging within the chute.

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Protection

4. Expedite installation of automatic sprinklers. Underground mains, hydrants and a source of water should be provided in the earliest stages of construction. Place sprinklers in service ahead of a combustible occupancy and immediately following combustible construction. Submit sprinkler plans promptly for review, comment and acceptance prior to ordering materials. Order all materials in advance of construction to assure delivery when needed. Construction sequences of various trades should be closely coordinated.
5. The FM Global Red Tag Permit System should be used to monitor all fire protection system impairments.

Ignition Source Control

6. Prohibit smoking in areas where combustibles are stored, where flammable liquids are stored or dispensed, near piles of debris, and on the roof. Post no smoking signs. Permit smoking only in designated areas equipped with proper receptacles.
7. The FM Global Hot Work Permit System should be used to monitor all applicable hot work operations.

Temporary Storage

8. Keep temporary combustible storage in the yard or on the roof (such as combustible roof insulation) to a minimum and limit to 6 ft in height and one or two pallets in width. Where space permits, the separation distance between adjacent storage piles and structures should be at least 20 ft, 25 ft, or 30 ft, for exposing storage widths of 4 ft, 6 ft, and 8 ft, respectively.

Equipment and High Value Storage

9. Arrange temporary storage of valuable and important equipment during construction in the following order of preference: (1) under sprinkler protection; (2) if no sprinklers, subdivided in moderate amounts in noncombustible buildings; and (3) if in combustible, unsprinklered buildings, provided with watch service, fire hose and extinguishers, heated by safe methods, and separated from other ignition sources. Subdivision in (2) above can be by walls with noncombustible surfaces or by clear spaces of 50 ft (15 m). When space and storage is limited, closer separation can be tolerated as outlined above (temporary storage).

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Appendix A

Table 1: Sprinkler Design Criteria

Occupancy Description	Exceptions	Hazard Category	Ceiling Up to 30 ft.		Ceiling from 30 to 45 ft.		Ceiling from 45 to 60 ft.		Ceiling from 60 to 100 ft.	
			Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
Apartments Classrooms Dormitories Kitchens Gymnasium Labs Libraries Offices Meeting rooms Restaurants Unused attic space		HC-1	0.1/1500	0.1/1500	0.2/2500	0.2/3500	0.2/2500	0.2/3500	Contact FM Global for assistance	Not an option.
Boiler rooms Parking Garages Sports Arenas Retail areas Theater & auditoriums Utility and equipment rooms	Libraries with large stacks or racks.	Contact FM Global for assistance.	0.2/2500	0.2/3500	0.2/2500	0.2/3500	0.2/2500	0.2/3500	Contact FM Global for assistance	Not an option.
Interior Loading Docks Convention Centers Theaters and Auditoriums with moderate to heavily loaded areas.	Generator rooms or boiler rooms with fuel oil.	Refer to guidelines on Emergency Generators and Boilers or contact FM Global for	0.3/2500	0.3/3500	0.3/3600	0.3/4600	0.5/3000	0.5/4000	Contact FM Global for assistance	Not an option.

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Table 2: Hose Stream Demand and Duration.

Hazard Category	Hose Demand, gpm		Duration, min.
	<i>Ceilings Under 60 ft.</i>	<i>Ceilings Over 60 ft.</i>	
HC-1	250	500	60
HC-2	250	500	60
HC-3	500	500	90

Table 3: Minimum Sprinkler K-factor for Hazard Category.

Hazard Category	Ceilings Height, ft.		
	<i>Up to 30 ft.</i>	<i>30-60 ft.</i>	<i>Over 60 ft.</i>
HC-1	5.6 or 5.6EC	8.0	25.2 or 25.2 EC
HC-2	8.0 or 11.2EC	8.0	25.2 or 25.2 EC
HC-3	11.2 or 11.2EC	11.2	25.2 or 25.2 EC

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Appendix B

Below are first pages from Form 85A FM Global *Contractor's Material & Test Certificate for Automatic Sprinkler Systems*, Contractor's Material & Test Certificate for *Underground Piping Form-85B*, and Form 2688 *Contractor's Application for Acceptance of Roofing System*. Complete electronic copies will be made available upon request.

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FM Global Contractor's Material & Test Certificate for Automatic Sprinkler Systems

Additional printed copies of this form are available to clients from:
Communication Services, FM Global, 270 Central Avenue, Johnston, RI 02919



Procedure: Upon completion of work, inspection and tests shall be made by the contractor's representative and witnessed by an owner's representative. All defects shall be corrected and system left in service before contractor's personnel finally leave the job.

A certificate shall be filled out and signed by both representatives. Copies shall be prepared for approving authorities, owners and contractor. It is understood the owner's representatives signature in no way prejudices any claim against the contractor for faulty material, poor workmanship or failure to comply with approving authority's requirements or local ordinances.

Contractor Information				Date:		
Contractor Company Name:						
Contractor Company Address:						
FM Global Client Information		FM Global Index No.:		FM Global Account No.:		
FM Global Client Building Owner or Tenant (Y/N)?				Building Name or No.:		
FM Global Client Name:						
FM Global Client Address:						
Description of Occupancy Being Protected:						
Automatic Sprinkler System Components and Materials						
Automatic Sprinklers:						
Manufacturer	Model / Trade Name	K-Factor	Temperature Rating	SIN	Year of Manufacture	Quantity
Automatic Sprinkler Pipe:						
Manufacturer	Model / Trade Name	Product Description	Schedule	Connection Type	Max. Working Pressure	

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Contractor's Material & Test Certificate for Underground Piping

Additional copies of this form are available to insureds from:
Customer Services, FM Global, 270 Central Avenue, Johnston, RI 02919

Procedure: Upon completion of work, inspection and tests shall be made by the contractor's representative and witnessed by an owner's representative. All defects shall be corrected and system left in service before contractor's personnel finally leave the job.

A certificate shall be filled out and signed by both representatives. Copies shall be prepared for approving authorities, owners and contractor. It is understood the owner's representatives signature in no way prejudices any claim against the contractor for faulty material, poor workmanship or failure to comply with approving authority's requirements or local ordinances.

Property I.D.

Property Name:		Date:	
Property Location:			

Plans:

Accepted By Approving Authority's Name(s)	
Address:	
Installation Conforms to Plans	☐ Yes ☐ No
Equipment Used is Approved (If no, state deviations):	☐ Yes ☐ No

Instructions:

Has person in charge of fire equipment been instructed as to the location of control valves and the care and maintenance of this new equipment?	☐ Yes ☐ No
If no, explain:	
Have copies of appropriate instructions and care and maintenance charts been left on premises?	☐ Yes ☐ No
If no, explain:	

Location:

Supplies Buildings:	
---------------------	--

Underground Pipes and Joints

Pipe Types & Class:	Type of Joint:
Pipe Conforms to	Standard. ☐ Yes ☐ No
Fittings Conform to	Standard. ☐ Yes ☐ No
If No, Explain:	
Joints needing anchorage clamped, strapped, or blocked in accordance with	standard.
☐ Yes ☐ No	
If no, explain:	

Test Description:

Flushing: Flow the required rate until water is clear as indicated by no collection of foreign material in burlap bags at outlets such as hydrants and blow-offs. Flush at flows not less than 390 GPM (1476 L/min) for 4 inch pipe, 880 GPM (3331 L/min) for 6 inch pipe, 1560 GPM (5905 L/min) for 8 inch pipe, and 2440 GPM (9235 L/min) for 10 inch pipe. When supply cannot produce stipulated flow rates, obtain maximum available.

Hydrostatic: Hydrostatic tests shall be made at not less than 200 psi (13.8 bars) for two hours or 50 psi (3.4 bars) above static pressure in excess of 150 psi (10.3 bars) for two hours.

Leakage: New pipe laid with rubber gasketed joints shall, if the workmanship is satisfactory, have little or no leakage at the joints. The amount of leakage at the joints shall not exceed 2 qts. Per hr. (1.89 L/h) per 100 joints irrespective of pipe diameter. The leakage shall be distributed over all the joints if such leakage occurs at a few joints, the installation shall be considered unsatisfactory and necessary repairs made. The amount of allowable leakage specified above may be increased by 1 fl. Oz. Per inch valve diameter per hour (30 mL/25mm/h) for each metal seated valve isolating the test section. If dry barrel hydrants are tested with the main valve open, so the hydrants are under pressure, an additional 5 Oz. Per Min. (150 mL/min) leakage is permitted for each hydrant.

Continued

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CHECKLIST FOR ROOFING SYSTEM



CONTACT INFORMATION:

INDEX NUMBER: _____

ROOFING CONTRACTOR (NAME & ADDRESS) _____	TELEPHONE NO.: _____	FAX: _____
	E-MAIL ADDRESS: _____	CONTACT: _____
CLIENT (NAME & ADDRESS) _____	TELEPHONE NO.: _____	FAX: _____
	E-MAIL ADDRESS: _____	CONTACT: _____

OVERVIEW OF WORK: (Submit 1 form per roof area)

Building Name & Number: _____			
Building Dimensions: Length: _____	ft/m: _____	Width: _____	ft/m: _____
Roof Slope: _____			
Parapet Height, max (in./m): _____		Parapet Height, min (in./m): _____	
Type of Work: ☐ New Construction ☐ Recover (New roof over existing Roofing System) ☐ Reroof (New cover/remove existing roofing system to deck) ☐ Other			
FM Approved RoofNav Assembly Numbers: _____			

ROOF SURFACING:

☐ None	
☐ Coating	_____ (Trade Name/Application Rate)
☐ Granules	_____ (Application Rate)
☐ Gravel/Slag	_____ (Application Rate)
☐ Ballast: ☐ Stone Size _____	☐ Pavers _____ (Beveled or square edge); ☐ Other: _____
Ballast Weight (psf): Field: _____	Perimeter: _____ Corners: _____

ROOF COVER/MEMBRANE:

(Please provide ALL applicable details including trade name, type, number of plies, thickness, reinforced, adhesive)

☐ Panel:	☐ Through Fastened Metal _____
	☐ Standing Seam metal _____
	☐ Fiber Reinforced Plastic (FRP) _____
	☐ Other: _____
☐ Single Ply:	☐ Adhered _____ ☐ Fastened _____ ☐ Ballasted _____
☐ Built Up Roofing (BUR)	_____
☐ Modified Bitumen	☐ Lap Width _____ in/mm ☐ Lap Adhesion Type _____
☐ Spray Applied	_____
☐ Other:	_____

BASE SHEET:

(Please include Trade Name, Type, and Width)

☐ None	
Trade Name: _____	Width: ☐ 36 in. ☐ 1 meter (39 in.)
☐ Fastened	☐ Adhered
☐ Secured per RoofNav	OR ☐ Per FM Global Loss Prevention Data Sheet 1-29
Comments: _____	
☐ Lap Width _____ in/mm	☐ Lap Adhesion Type _____
☐ Air Retarder _____	☐ Vapor Retarder _____

INSULATION

Layer	Trade Name	Thickness (in.)	Fastened	Adhered	Tapered
1. Top	_____	_____	☐	☐	☐
2. Next	_____	_____	☐	☐	☐
3. Next	_____	_____	☐	☐	☐
4. Next	_____	_____	☐	☐	☐
☐ Glass Fiber/Mineral Wool/Batt		☐ Facer Type/Vapor Barrier _____			
☐ Thermal Barrier _____					

X2688 ENGINEERING (Rev. Oct 2016)

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