FIRE DEPARTMENT • CITY OF NEW YORK

STUDY MATERIAL
FOR THE EXAMINATION FOR
CERTIFICATE OF FITNESS
FOR

G-92

Supervision of High-Pressure Natural Gas Fired Microturbine Systems

1/15/2008

INSIDE THIS BOOKLET YOU WILL FIND THE FOLLOWING:

- **NOTICE OF EXAMINATION (NOE)**
- **STUDY MATERIAL**

NOTICE OF EXAMINATION FOR

Title: Examination for the Certificate of Fitness for Supervision of High-Pressure Natural Gas Fired Microturbine Systems (G-92).

Date of Test: Written tests are conducted Monday through Friday (except legal holidays) 9:00 AM to 2:30 PM.

QUALIFICATION REQUIREMENTS

1. Applicants must be at least 18 years of age.
2. Applicants must have a reasonable understanding of the English language.
3. Applicants must present a letter of recommendation from his/her employer. The letter must be on official letterhead and must state the applicant's full name, character, physical condition, experience, address of premises where applicant will be employed, and the model and type of high-pressure natural gas fired microturbine system(s) installed.
4. Applicants must present two (2) forms of satisfactory identification i.e., driver's license and passport picture ID.
5. Applicants must submit written evidence of microturbine manufacturer's training in the specific equipment operation and safety procedures for the equipment installed at the COF applicants' work place(s).

APPLICATION INFORMATION

Application Fees: $25.00 for originals and $15.00 for renewals. The fee may be paid in cash, money order, or personal check payable to New York City Fire Department. The $25.00 fee must be payable by all applicants prior to taking the Certificate of Fitness test.

Application forms are available at the Public Certification Unit, 9 MetroTech Center, 1st floor, Brooklyn, NY 11201.

TEST INFORMATION

Test: The test will be of the written, multiple choice type. A passing score of at least 70% is required in order to secure a Certificate of Fitness. Call (718) 999-1986 for additional information and forms.

ABOUT THE STUDY MATERIAL

The study material will help the applicant prepare for the written examination for the Certificate of Fitness (G-92) for supervision of high-pressure natural gas fired microturbine systems.

This study material **does not** contain all the information you need to know to work with natural gas and high-pressure natural gas fired microturbine systems. It is your responsibility to become familiar with all applicable rules and regulations of the City of New York, even if they are not covered in this study material.

ABOUT THE WRITTEN TEST

You must pass a multiple choice test to qualify for the Certificate of Fitness. A score of 70% correct is required in order to pass the multiple choice test. All questions on the multiple choice test have four answer options. Only one answer option is correct for each question. If you do not answer a question, or if you mark more than one option, your answer will be scored as incorrect. Read each question carefully before marking your answer. There is no penalty for guessing on the multiple choice test.

Sample Questions

1. The first President of the United States was:

(A) Bill Clinton.
(B) Abraham Lincoln.
(C) George Washington.
(D) Ronald Reagan.

The correct answer is "**C**". You would press "**C**" on your touch-screen monitor.

2. The capital of New York State is:

(A) Albany.
(B) Washington D.C.
(C) New York City.
(D) Buffalo.

The correct answer is "**A**". You would press "**A**" on your touch-screen monitor.

NATURAL GAS

Natural gas is a gaseous fossil fuel consisting primarily of methane but includes significant quantities of ethane, butane, propane, carbon dioxide, nitrogen, helium, and hydrogen sulfide. Nitrogen, helium, carbon dioxide, and trace amounts of hydrogen sulfide, water, and odorants are also present in trace amounts.

Natural gas is often informally referred to as simply **"gas"**, especially when compared to other energy sources such as petroleum product. Before natural gas can be used as a fuel it must undergo extensive processing to remove almost all materials other than methane.

The methane content can range from 87% to 96% with ethane, propane and other hydrocarbon gases making up the remainder. Due to the large methane content in natural gas, its properties are very similar. It is assumed to behave as methane.

Processed natural gas is tasteless and odorless. However, before gas is distributed to end-users, it is odorized by adding small amounts of odorants (mixtures of t-butyl mercaptan, isopropyl mercaptan, tetrahydrothiophene, dimethyl sulfide and other sulfur compounds), to assist in leak detection. Breathing natural gas in trace amounts is harmless, however, natural gas is a simple asphyxiant and can kill if it displaces air to the point where the oxygen content will not support life.

Natural gas is a flammable gas. It can be hazardous to life and property by explosion. Natural gas is lighter than air, due to its specific gravity of 0.60 which is lower than that of air (1.00), natural gas rises and tends to escape into the atmosphere. However, when natural gas is confined, such as within a building or other enclosed space, gas concentrations can reach explosive mixtures and, if ignited, result in blasts that could level and destroy buildings. Methane has a lower explosive limit of 5% in air, and an upper explosive limit of 15%. The lower and upper explosive limits are sometimes referred as lower flammable limit and upper flammable limit.

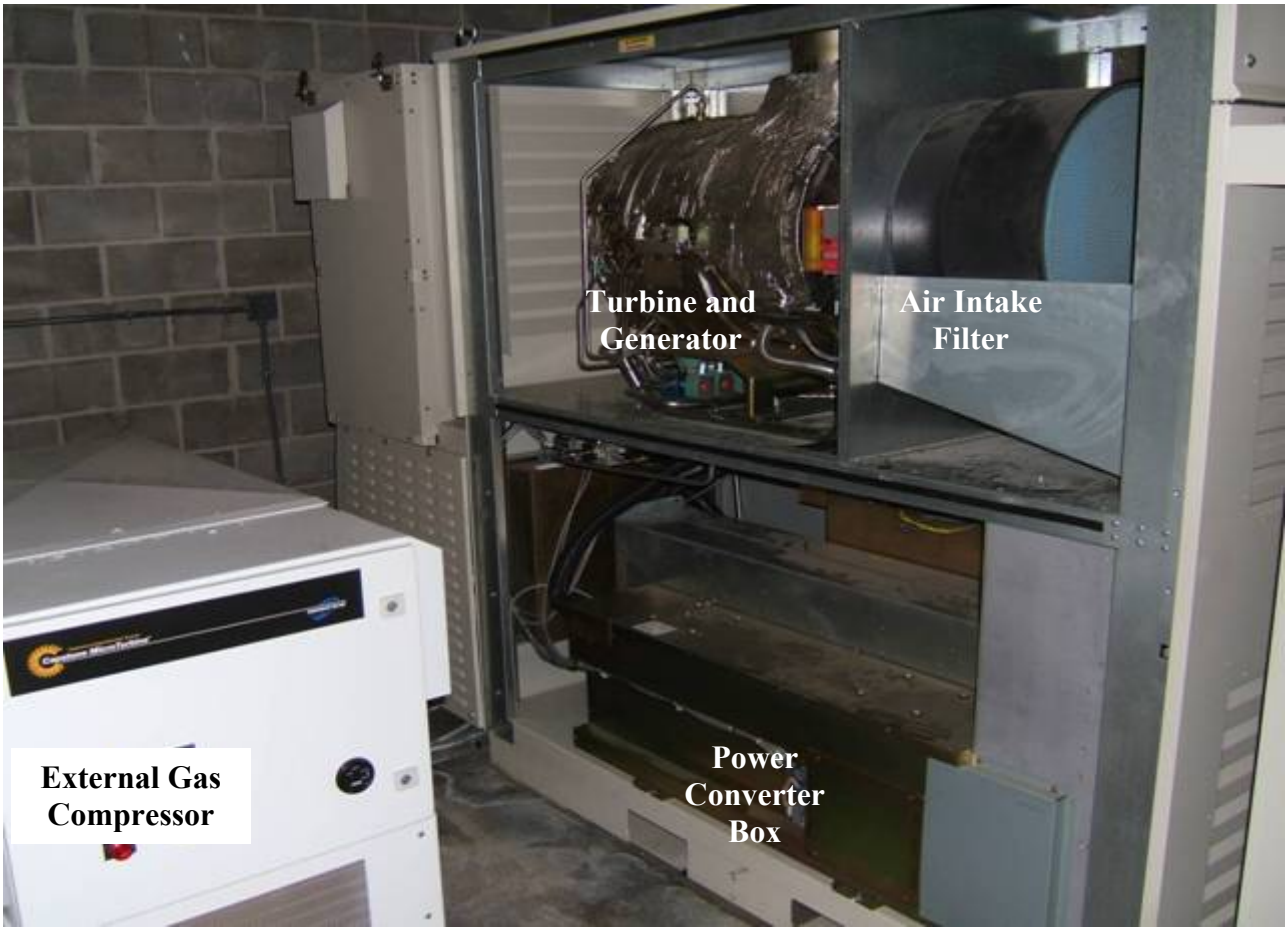
Another important characteristic for natural gas is the autoignition or ignition temperature. Natural gas autoignition temperature in air is 998^0F, or 537^0C, and represents the temperature at which it can self-ignite without any obvious source of ignition, such as a spark or flame.

ANY NATURAL GAS LEAK SHALL BE REGARDED AS A SERIOUS HAZARD THAT REQUIRES IMMEDIATE RESPONSE!

INTRODUCTION

Microturbines are a relatively new generation technology being used for stationary energy generation applications. They can be used in electricity-only generation, or to produce both heat and electricity, referred to as Synchronous heat and power, or CHP. Microturbines offer several potential advantages compared to other technologies for small-scale power generation, including: a small number of moving parts, compact size, lightweight, greater efficiency, lower emissions, lower electricity costs, and opportunities to utilize waste fuels.

Because of their small size, relatively low capital costs, expected low operations and maintenance costs, and automatic electronic control, microturbines are expected to capture a significant share of the market. In addition, microturbines offer an efficient and clean solution to direct mechanical drive markets such as compression and air conditioning.

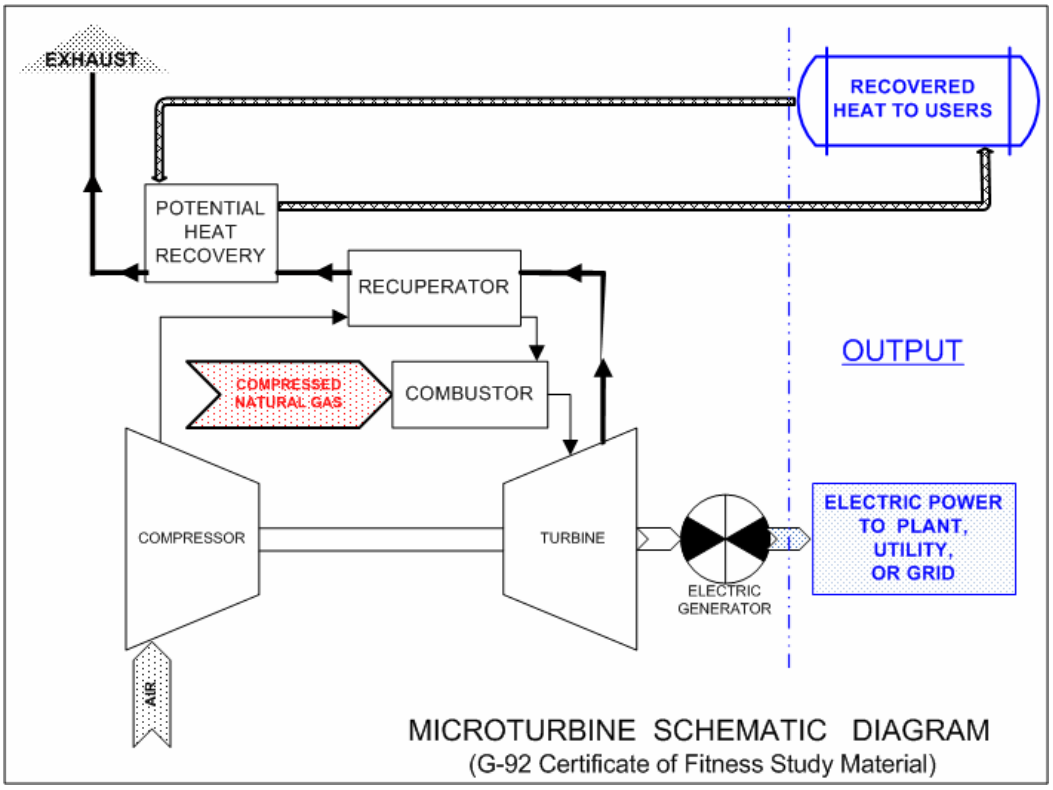


Microturbines are small combustion turbines approximately the size of a refrigerator with outputs of 25 kW to 500 kW. They evolved from automotive and truck turbochargers, auxiliary power units for airplanes into highly sophisticated and complex equipment. Most microturbines are comprised of a compressor, combustor, turbine, alternator, recuperator (a device that captures waste heat to improve the efficiency), and electric generator.

The construction complexity of microturbine systems varies based on output and efficiency characteristics. Microturbine systems can be divided into two general classes:

- ***Unrecuperated (or simple cycle) microturbines***—In a simple cycle, or unrecuperated, turbine, compressed air is mixed with fuel and burned under constant pressure conditions. The resulting hot gas is allowed to expand through a turbine to perform work. Simple cycle microturbines have lower efficiencies at around 15%, and provide more heat available for cogeneration applications than recuperated units.

- ***Recuperated microturbines***—Recuperated units use a sheet-metal heat exchanger that recovers some of the heat from an exhaust stream and transfers it to the incoming air stream, boosting the temperature of the air stream supplied to the combustor. Further exhaust heat recovery can be used in a cogeneration configuration. The fuel-energy-to-electrical-conversion efficiencies are in the range of 20% to 30%. In addition, recuperated units can produce 30% to 40% fuel savings from preheating.



Microturbine systems' efficiency generally decreases at elevated ambient temperatures.

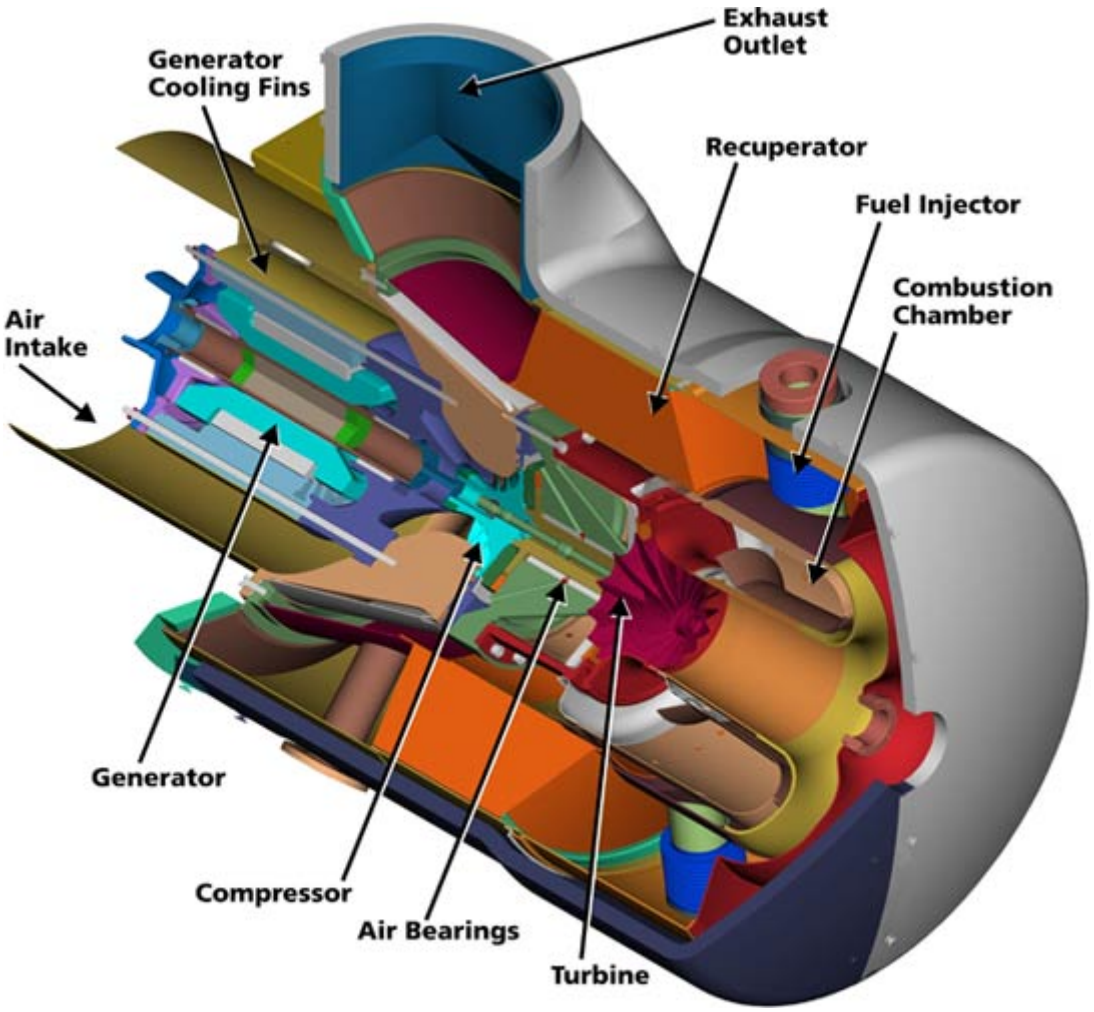
The microturbine systems are air cooled and some designs use air bearings, thereby eliminating both water and oil cooling systems used by reciprocating engines**.** Microturbines operate on either oil-lubricated or air bearings, which support the shaft(s).

Oil-lubricated bearings are mechanical bearings and come in three main types - high-speed metal roller, floating sleeve, and ceramic surface. The ceramic surface provides the longest life, operating temperature, and lubricant flow. Oil-lubricated bearings require an oil pump, oil filtering system, and liquid cooling.

Air bearings do not require any oil or oil pump. Air bearings permit high speed operations while operating with very low vibration levels. Air bearings may lengthen microturbine startup time.

GAS TURBINE PROCESS DESCRIPTION

A gas turbine is an internal combustion engine that operates with rotary rather than reciprocating motion. Gas turbines are essentially composed of three major components: compressor, combustor, and power turbine. In the compressor section, ambient air is drawn in and compressed from the ambient pressure. It is directed to the combustor section where fuel is introduced, ignited, and burned.



ELECTRIC GENERATORS

The highest efficiency operating speeds of microturbines tend to be quite high, often exceeding 100,000 revolutions per minute (rpm). The speeds are generally variable over a wide range (i.e., from 50,000 rpm to 120,000 rpm) to accommodate varying loads while maintaining both high efficiency and optimum long-term reliability.

The microturbine drives generator that may be either synchronous or asynchronous (or non-synchronous). Because induction generators need external power, they will not operate unless connected to the power grid. This makes them unsuitable for use as backup power sources. Synchronous generators can operate without external power.

Power requirements to the generator vary depending on the design. For example, a synchronous generator with a wound rotor assembly will require DC power for energizing the rotor poles. An asynchronous generator requires a 3-phase current.

To allow for transients and voltage spikes, power electronics designs are generally able to handle seven times the lowest voltage. Most microturbine power electronics are generating three-phase electricity.

Electronic components also direct all of the operating and startup functions. Microturbines are generally equipped with controls that allow the unit to be operated in parallel or independent of the grid, and internally incorporate many of the grid and system protection features required for interconnect. Electronic controls also allow for remote monitoring and operation.

HIGHLIGHTS FROM THE N.Y.C. DEPARTMENT OF BUILDINGS' RULE §50-01. APPLICANTS ARE STRONGLY ENCOURAGED TO READ THE ENTIRE RULE, AND THE REFERENCED SOURCES LISTED IN THE BIBLIOGRAPHY.

ALLOWABLE CAPACITIES OF HIGH-PRESSURE NATURAL GAS FIRED MICROTURBINE SYSTEMS IN NEW YORK CITY

Microturbine systems utilize natural gas at an inlet pressure to the system of not greater than 3 psig, and boost the gas pressure to an inlet pressure to the combustion device of greater than 15 psig within the unit or a room enclosure. The entire high-pressure line, from the inlet to the compressor through to the combustor, must conform to the requirements for a gas train. Section 3.3.5 of NFPA 37 "Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines", defines a gas train as the portion of the fuel gas supply pipe starting with and including the equipment isolation valve and extending to the point at which the gas fuel enters the prime mover.

Installed microturbine systems are permitted to include one or more combustion-based turbine-driven electrical generators with 500 kW or less capacity, natural gas compressing equipment, heat recovery devices, electrical power distribution devices, gas vents or chimneys, and other associated appurtenances.

The total nominal electrical capacity at standardized operating conditions of all microturbine systems located within a single building in New York City shall not exceed 2,000 kW.

GENERAL INSTALLATION REQUIREMENTS IN NEW YORK CITY

Installation of microturbine systems shall be in accordance with all applicable requirements of the RCNY §50-01, the New York City Electrical Code and the New York City Administrative Code (Building Code and Reference Standards). NFPA 37 "Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines" shall also apply, except where the NYC rules and regulations are more restrictive. Such regulations include, but are not limited to the following: fuel gas piping, egress, fire protection, fire detection, electrical power, ventilation, and gas vent or chimney.

The microturbine system configurations with an external compressor shall satisfy the following requirements:

1. Gas connections between the compressor and the turbine shall be solid-welded; no threaded joints are permitted.

2. A flame arrestor has to be installed upstream of the gas compressor to prevent flame propagating to the natural gas fuel distribution lines.

3. The length of gas piping connecting the gas compressor with the combustion device, both of which shall be in the same room, shall not exceed 12 feet.

All annunciations shall be provided locally and remotely to indicate any abnormal conditions in the system. The remote panel shall be located in a continuously supervised area on the premises.

Gas supply to the microturbine shall be provided with an automatic shut-off valve that is activated by a malfunction alarm from any component of the microturbine system.

A remote located motorized fail-in-place gas shut-off valve shall be positioned immediately after the branch connection providing dedicated service to the microturbine installation. The valve shall be manually controlled at the valve and remotely controlled both outside the door(s) to the microturbine room and at a supervised location. The motorized fail-in-place gas shutoff valve and the controls shall each be clearly identified with signs indicating "EMERGENCY GAS SHUT-OFF TO MICROTURBINE."

Diagrams shall be conspicuously posted on any door or gate leading to a microturbine indicating the locations of all manual and automatic fuel shut-off valves and safety devices.

The microturbine shall be provided with adequate protection from theft, tampering and unauthorized use. Access to microturbine systems shall be restricted by locked doors but shall be readily accessible to maintenance and repair personnel and to Fire

Department representatives. Microturbines installed outdoors shall be adequately protected from vehicle impact.

Signs clearly notifying "HIGH PRESSURE GAS" shall be posted on or in front of the microturbine or microturbine system, and on the outside of all doors accessing any microturbine room.

All manufacturer's requirements and recommendations shall be closely followed and complied with.

PERMITTED LOCATIONS FOR THE INSTALLATION OF HIGH-PRESSURE NATURAL GAS FIRED MICROTURBINE SYSTEMS

Acceptable locations where high-pressure natural gas fired microturbine systems can be installed in New York City are:

1. Outdoors at grade, on a roof or on a roof setback, within an integral weatherproof or lightweight enclosure acceptable to the manufacturer.
2. Within a dedicated Mechanical Equipment Penthouse classified as Occupancy Group D-2.
3. Within a dedicated room in a building.
4. Within a boiler or other mechanical equipment room of a building.

OUTDOORS AT GRADE, ON A ROOF OR ON A ROOF SETBACK, WITHIN AN INTEGRAL WEATHERPROOF OR LIGHTWEIGHT ENCLOSURE ACCEPTABLE TO THE MANUFACTURER:

All components of the microturbine system shall be located a minimum of 4 feet from a wall or parapet, 8 feet from any building opening, including any door, operable window or intake opening and 5 feet from any exhaust termination or chimney.

All microturbine systems located at grade shall satisfy the following clearances:

A. 50 feet from any subway entrance, exit, vent or other opening;

B. 20 feet from any above-ground flammable or combustible liquid storage tank;

C. 10 feet from any lot line, except 4 feet from any lot line in and adjacent to a manufacturing district;

D. 5 feet from any vent or fill line of any flammable or combustible liquid storage tank;

E. 5 feet from any parked motor vehicle.

All microturbine system components shall be contained within integral weather-proof enclosures pursuant to the listing for the device. The unit enclosure or the lightweight constructed enclosure shall be provided with a gas detection system with an alarm that annunciates in a supervised location. Equipment not directly associated with the microturbine system shall not be permitted in the same enclosure.

WITHIN A DEDICATED MECHANICAL EQUIPMENT PENTHOUSE CLASSIFIED AS OCCUPANCY GROUP D-2:

The mechanical equipment penthouse shall be enclosed within 2-hour fire-resistance rated walls.

The equipment room shall be fully sprinklered or provided with an equivalent fire suppression system approved by the New York City Department of Buildings.

Mechanical ventilation shall be provided for the mechanical equipment penthouse at a rate sufficient to dissipate sensible heat released from the microturbine system in accordance with the manufacturer's recommendations, at a rate adequate to dilute the microturbine system rated flow rate of fuel gas below 25 percent of the lower flammability limit (LFL) of the fuel gas, or at an exhaust and make-up air rate of 80 times the maximum leakage rate of natural gas from the high-pressure system within the room at standard temperature and pressure based on the rated capacity of the gas compressor, whichever is greater. The ventilation rate shall not be less than required to maintain the ambient room temperature within the manufacturer's recommendations but shall not exceed 104 degrees Fahrenheit. Proper distribution of exhaust and make-up air must be provided to prevent pockets of increased gas concentration, including exhaust points high in the room to address the lighter-than-air properties of natural gas. Mechanical ventilation shall operate continuously.

The mechanical equipment penthouse shall be provided with a gas detection system with an alarm that annunciates in a supervised location.

The mechanical equipment penthouse shall be provided with adequate lighting in accordance with the New York City Building Code.

Equipment not directly associated with the microturbine system, including but not limited to gas meters, shall not be permitted within the mechanical equipment penthouse.

No combustible materials shall be stored in the mechanical equipment penthouse.

WITHIN A DEDICATED ROOM IN A BUILDING:

The total installed rated capacity of the microturbine system in the room shall not exceed 1,000 kW.

The microturbine room shall be enclosed within 2-hour fire-resistance rated walls.

The equipment room shall be fully sprinklered or provided with an equivalent fire suppression system approved by the New York City Building Department.

Mechanical ventilation shall be provided for the microturbine room at a rate sufficient to dissipate sensible heat released from the microturbine system in accordance with the manufacturer's recommendations, at a rate adequate to dilute the microturbine system rated flow rate of fuel gas below 25 percent of the lower flammability limit (LFL) of the fuel gas, or at an exhaust and make-up air rate of 80 times the maximum leakage rate of natural gas from the high-pressure system within the room at standard temperature and pressure based on the rated capacity of the gas compressor, whichever is greater. The ventilation rate shall not be less than required to maintain the ambient room temperature within manufacturer's recommendations but not to exceed 104 degrees Fahrenheit. Proper distribution of exhaust and make-up air must be provided to prevent pockets of increased gas concentration, including exhaust points high in the room, to address the lighter-than-air properties of natural gas. Mechanical ventilation shall operate continuously.

The microturbine room shall be provided with a gas detection system with an alarm that annunciates in a supervised location.

The microturbine room shall be provided with adequate lighting in accordance with the New York City Building Code.

Equipment not directly associated with the microturbine system, including but not limited to gas meters, shall not be permitted within the microturbine room.

No combustible materials shall be stored in the microturbine room

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WITHIN A BOILER OR OTHER MECHANICAL EQUIPMENT ROOM OF A BUILDING:

The total installed rated capacity of the microturbine system in this room shall not exceed 500 kW.

The mechanical equipment room shall be enclosed within 2-hour fire-resistance rated walls.

The mechanical equipment room shall be fully sprinklered or provided with an equivalent fire suppression system approved by the New York City Building Department.

Mechanical ventilation shall be provided for the mechanical equipment room at the rate sufficient to dissipate sensible heat released from all gas-burning equipment located within the mechanical equipment room in accordance with the microturbine manufacturer's recommendations, at a rate adequate to dilute the microturbine system rated flow rate of fuel gas below 25 percent of the lower flammability limit (LFL) of the fuel gas, or at an exhaust and make-up air rate of 80 times the maximum leakage rate of natural gas from the high-pressure system within the room at standard temperature and pressure based on the rated capacity of the gas compressor, whichever is greater. The ventilation rate shall not be less than required to maintain the ambient room temperature within the manufacturer's recommendations but shall not exceed 104 degrees Fahrenheit. Proper distribution of exhaust and make-up air must be provided to prevent pockets of increased gas

concentration, including exhaust points high in the room, to address the lighter-than-air properties of natural gas. Mechanical ventilation shall operate continuously.

The mechanical equipment room shall be provided with a gas detection system with an alarm that annunciates in a supervised location.

The mechanical equipment room shall be provided with adequate lighting in accordance with the New York City Building Code.

Gas meters shall not be permitted within the mechanical equipment room.

No combustible materials, including fuels, shall be stored in the mechanical equipment room.

SERVICE CONTRACT

Owners of high-pressure natural gas fired microturbine systems are required to obtain a service contract from the microturbine manufacturer or a service company qualified by the manufacturer and such service contract shall be maintained during the life of the installation.

Emergency names, phone numbers, times, and additional contact information, for the service providers should be posted at conspicuous locations and on every diagram and warning sign posted on premise. The Certificate of Fitness holder should establish and maintain a fast method of contact, and should keep a direct dialog with the authorized service personnel, and shall maintain all information posted current and accurate.

The manufacturer should establish a recommended scheduled preventive maintenance program, adapted for each customer and each microturbine model. The preventive maintenance program should include the determined service intervals, and specific responsibilities for the manufacturer and for the end user. Copy of the preventive maintenance schedule should be available on the premise and shall document the work performed, who performed the work, and recommendations following each service, and other relevant information determined.

GENERAL SAFETY REGULATIONS

The Certificate of Fitness holder should periodically conduct a visual inspection of all high-pressure natural gas fired microturbine systems that are in use. Such inspections should be conducted as frequently as needed to ensure safe operation. All equipment that is connected for use but not in use, including the outdoor gas service line shut-off valve, should be inspected at least once every work day. The certificate of fitness holder should ensure that all gas piping, appliances and equipment are in a safe condition and proper working order and are maintained and operated safely and in compliance with the prescribed installation requirements.

High-pressure natural gas fired microturbine systems should be operated with all panels, covers, and guards in place. Any part or component removed for service, maintenance, or cleaning must be properly re-installed before use. The internal cooling of the microturbine equipment can be affected by operating the microturbine without external panels in place and the equipment can overheat and be damaged.

The manufacturer or qualified service personnel should be notified of any abnormal situation and consulted when additional information is needed on site.

The Certificate of Fitness holder should not attempt to perform any repairs to the high-pressure natural gas fired microturbine systems. This equipment is very sensitive and shall be serviced and/or repaired by a representative of the manufacturer or an authorized professional in accordance with the manufacturer's instructions.

The particular requirements for the operation of different type of microturbine systems are entirely distinctive, as specified by the manufacturers' characteristics and construction constraints. The operation of some microturbine systems is monitored by manufacturer from a remote location. The manufacturer recommends as the only intervention to the microturbine operation that is to be performed by personnel other than the manufacturer's technical network, such a Certificate of Fitness holder, is just the shut-off the equipment in case of malfunction or emergency. Regular maintenance is highly recommended and by receiving thorough training by the manufacturer for safe operations.

The enclosure panels shall not be removed without performing the maintenance shutdown of the unit. Hot surfaces, high voltage, and rotating machinery can cause serious injury or death.

Microturbines exhaust ducts can reach high temperatures that are hot enough to cause severe burn injuries if touched, and even fires in contact with combustible materials. The duct outlets shall be allowed to discharge the hot exhaust unobstructed. Warning signs shall be posted to instruct where the possibility any danger caused by hot exhaust exists. The integrity of the high temperature insulation around the exhaust ducts penetrating walls or roofs shall be verified periodically.

Where the operation of an emergency shut-off switch on a microturbine system may initiate an immediate shutdown of the microturbine system and its components, other than the routine stop, a warning sign shall be posted about the limitation of using such switch. It is recommended the posting of the normal startup and shutdown procedures with listing of all steps to turn on and off the unit and components.

When an emergency or maintenance shutdown of the unit is performed, the shut-off valve that is located immediately after the branch connection providing dedicated service to the microturbine system shall be manually turned off.

Electrical conductors and cables inside the microturbine systems and cables connected to the microturbine systems shall not be touched. When performing emergency or maintenance shutdowns of the microturbine systems it is prudent to implement an electrical cutoff of the units, which should include a waiting time period before it is safe to open the panels and perform work inside the units. Special care shall be exerted even after the high

voltage electrical equipment is disconnected using a switch, since it is possible that it may retain residual power and an electric charge for a period of time.

On the microturbine systems using battery packs, the danger of electric shock is present. Also, the release of small amounts of sulfuric acid and hydrogen gas may be a potential hazard.

NATURAL GAS MAIN LINE

- All gas piping shall be installed, maintained, and repaired only by New York City Licensed Plumbers.
- A remote located motorized fail-in-place gas shut-off valve shall be positioned immediately after the branch connection providing dedicated service to the microturbine installation. The valve shall be manually controlled at the valve and remotely controlled both outside the door(s) to the microturbine room and at a supervised location. The motorized fail-in-place gas shutoff valve and the controls shall each be clearly identified with signs indicating "EMERGENCY GAS SHUT-OFF TO MICROTURBINE."
- Gas supply to the microturbine shall be provided with an automatic shut-off valve that is activated by a malfunction alarm from any component of the microturbine system.
- All annunciations shall be provided locally and remotely to indicate any abnormal conditions in the system. The remote panel shall be located in a continuously supervised area on the premises.
- The natural gas emergency switch and shut-off valves shall be identified by durable signs and shall be located at easy accessible unlocked locations.

RECORD KEEPING

At least one copy of the manufacturer's operating and maintenance instructions for the microturbine systems, and the plans approved by the Department of Buildings for the high-pressure natural gas fired microturbine systems should be readily available on the premises.

A bound log book shall be kept on the premise by the Certificate of Fitness holder to document the operation of the microturbine systems. **The log book should record the hours of operation of the equipment, the routine maintenance and the repairs performed.** All daily inspections performed to the microturbine systems and related equipment, including any action taken should be documented by the Certificate of Fitness holder in the log book. Manufacturers, such as Ingersoll-Rand Energy Systems, mandate to keep in a log book a written record of all maintenance records and any necessary service and repairs.

Where applicable, a copy of the recommended scheduled preventive maintenance program, recommended by the manufacturer, shall be available on the premise and shall document the work performed, who performed the work, and recommendations following each service, and other relevant information.

The log book, permits, and Certificates of Fitness copies must be made available to Fire Department representatives upon request.

GENERAL INSPECTION CHECKLIST

The certificate of fitness holder should make regular inspections of the high-pressure natural gas fired microturbine systems. These inspections will vary depending on the location and on the microturbines installed. However, the following general guidelines will apply for all locations:

- The entire premise must be checked daily for potential signs of equipment malfunction and gas leaks. Any potential malfunction or hazard where high-pressure natural gas fired microturbine systems are operated, must be corrected immediately by a representative of the manufacturer or an authorized professional in accordance with the manufacturer's instructions.

- Aspects specific to each installation, should be dealt with in a proficient manner. Such as, defective electronic components that must be replaced or properly repaired; hazards presented by exposed electrical wires that could be high voltage conductors, etc.

- Rubbish and other combustible waste should not to be allowed to accumulate indoors. This is a fire hazard, and it may be easily ignited. All rubbish and other combustible waste should be promptly removed from the premises.

- Manufacturers' specified clearances, minimum ceiling heights for indoor units and minimum unobstructed floor areas around units shall be verified and maintained.

- Proper and continuous operation of the indoor mechanical ventilation systems, and monitoring of the environmental conditions and operating temperature should be monitored.

The Fire Department recommends the use of a portable combustible gas leak detector that should be readily available on the premises. In the absence of such portable combustible gas leak detector, natural gas connections must be checked when a leak is suspected using a soap and water solution.

A lighted flame (for example, a match or a propane torch) should never be used when investigating a possible natural gas leak.

A permit shall be obtained from the Fire Department prior to the operation of high-pressure natural gas fired microturbine systems. The permit shall be issued in the name of the owner of the property, upon application of the owner or a registered architect, professional engineer or contractor on the owner's behalf.

Permit applications shall be filed with the Department's Bureau of Fire Prevention at Fire Department Headquarters. The permit application shall include such information and documentation as the Department may prescribe, including but not limited to a completed application form, copy of approved plans and a copy of the work permit issued by the New York City Department of Buildings authorizing the installation of high-pressure natural gas fired microturbine systems.

All required Fire Department permits and Certificates of Fitness must be obtained prior to operation of the microturbines and copies of the permit and Certificates of Fitness shall be conspicuously posted on the premises.

FIRE EXTINGUISHERS

All fire extinguishers must be conspicuously located. Signs must be conspicuously posted indicating the locations of the extinguishers. Signs describing how to use the fire extinguishing devices must also be posted. The certificate of fitness holder must make sure that the extinguishers are inspected at the designated time intervals. The fire extinguishers must be recharged after each time they are used, or as required for the type of extinguisher provided.

The certificate of fitness holder must know how and when to operate all fire extinguishers installed at the premise. The classes of fires and the appropriate extinguishers are described below.

Class A Fires Class A fires occur when ordinary combustible materials are ignited. For example, wood and paper fires are class A fires. Water type extinguishers should be used to extinguish these fires because they cool the fire while quenching the flame.

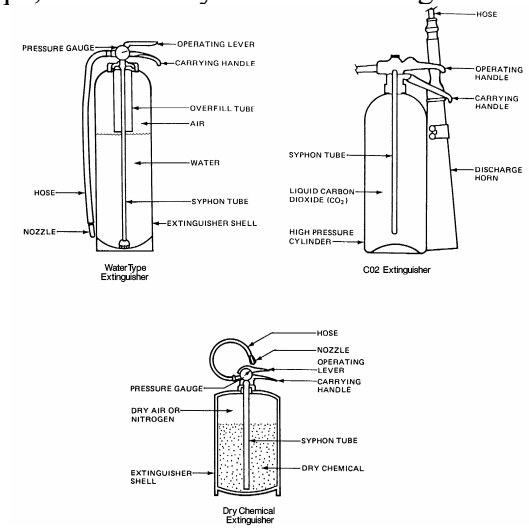
Class B Fires Class B fires occur when flammable liquids, gases or greases are ignited. These fires must be extinguished by smothering the flame. The flame may be smothered using carbon dioxide, dry chemical or foam extinguishers. Water type extinguishers will not effectively extinguish class B fires.

Class C Fires Class C fires occur when electrical equipment catches fire. These fires must be fought with fire extinguishers that do not conduct electricity. Carbon dioxide and dry chemical extinguishers must be used to extinguish electrical fires. Foam and water type extinguishers must not be used to extinguish electrical fires.

Class D fires Class D fires are caused by ignitable metals, such as magnesium, titanium, and metallic sodium, or metals that are combustible under certain conditions, such as calcium, zinc, and aluminum. Generally, water should not be used to extinguish these fires.

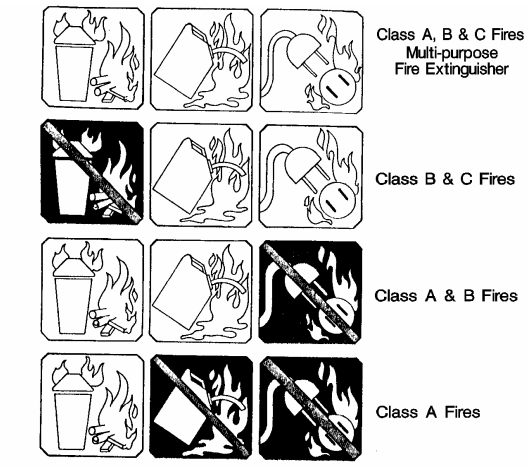
A multi-purpose dry chemical fire extinguisher may be used to extinguish Class A, B, or C fires.

Examples of Water type, C02 and Dry Chemical extinguishers are shown below.



Fire Extinguishers

Symbols may also be painted on the extinguisher. The symbols indicate what kind of fires the extinguisher may be used on. Examples of these symbols are shown below.



Symbols Painted on Fire Extinguishers

A symbol with a shaded background and a slash indicates that the extinguisher must not be used for that type of fire. The certificate of fitness holder must understand these symbols and must make sure that the fire extinguishers are kept in good working order at all times. Generally, operation instructions are clearly painted on the side of the fire extinguisher. They clearly describe how to use the extinguisher in case of an emergency. An example of these instructions is shown below.

Operation Instructions for a Fire Extinguisher

PLANNING FOR EMERGENCIES

Every premise where high-pressure natural gas fired microturbine systems are installed and operated should have an emergency response plan detailing procedures that must be followed during an emergency, fire, natural gas leak or other urgent situation. The plan should include methods for fast and safe evacuation of the premise. The certificate of fitness holder must know and understand his or her responsibilities as they are outlined in the premise's emergency response plan. **These responsibilities may include shutting off the microturbine systems and gas supplies, notifying the Fire Department, notifying the maintenance service personnel, assisting in the safe evacuation of the place, and extinguishing fires.**

The certificate of fitness holder must know the locations and how to operate all fire extinguishing devices and control devices installed at the facility. He or she must also know the locations of each fire alarm station on the premises, if applicable, and how to operate them.

The Fire Department strongly recommends that employees, occupants, and residents on premises where microturbine systems are installed, should be encouraged and trained to alert the Certificate of Fitness holder, maintenance service providers, and the Fire Department immediately at any sign of danger. If possible, training sessions should be conducted periodically and all personnel, occupants, and residents should be knowledgeable of the safety procedures that must be followed during an emergency.

Below are presented some samples for the procedures that should be included and detailed in the emergency response plan. However, such procedures should be customized for each premise:

Sample of Procedures in Case of a Microturbine System Fire:

1. Turn off the microturbine system from a distant location.

2. Open and lock the electrical disconnect switch.

In all cases, the Fire Department **must** be contacted directly by phone in case of an emergency, dialing **911**. It is suggested to have the Fire Department Borough Communication Office phone numbers posted near the telephones most likely to be used in case of an emergency. These phone numbers are:

Manhattan	**(212) 999-2222**
Bronx	**(212) 999-3333**
Brooklyn	**(718) 999-4444**
Queens	**(718) 999-5555**
Staten Island	**(718) 999-6666**

Additional Sample of Procedures in Case of Natural Gas Leak. Contact the manufacturer for specific procedures for your equipment.

1. Immediately cease operation of the microturbine system and related equipment (gas compressors, etc.).

2. DO NOT turn any electrical switches; DO NOT use any cellular phone in the area, DO NOT use any device that can cause sparks, or sources of ignition in the area of the natural gas leak.

   A. Close ALL natural gas fuel shut-off valves, if possible.

   B. Ventilate the area, if possible.

   C. Use a gas leak detector verify all pipes and connections to investigate if there is natural gas leaking with the gas valves closed.

   D. Do Not turn the equipment or the gas service on, before trained service personnel and New York City Licensed Plumbers investigate the equipment and gas piping, and before finding and full remediation of the condition causing the natural gas leak.

BIBLIOGRAPHY:

- Installation natural gas fired microturbine systems shall comply with Section §50-01 entitled "Requirements for the Installation of High-Pressure Natural Gas-Fired Microturbine Systems" of Chapter 50 "Distributed Energy Resource Standards" of Title 1 of the Rules of the City of New York.

- The installation of gas piping shall comply with Subchapter 16 and Section §P115 of RS 16 of Chapter 1 of Title 27 of the New York City Administrative Code.

- American National Standards Institute (ANSI) Z223.1 and National Fire Protection Association (NFPA) Standard 54 "National Fuel Gas Code".

- National Fire Protection Association (NFPA) Standard 37 "Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines", 2006 Edition.

- New York City Electrical Code.

- Materials and Equipment Acceptance Resolutions (MEA) issued by the Department of Buildings for natural gas compressor of the microturbines with external compressors.

- Manufacturers' manuals, specifications, and instructions for the high-pressure natural gas fired microturbine systems.

CHAPTER 50

DISTRIBUTED ENERGY RESOURCE STANDARDS

OF TITLE 1 OF THE RULES OF THE CITY OF NEW YORK

§50-01 REQUIREMENTS FOR THE INSTALLATION OF HIGH-PRESSURE NATURAL GAS-FIRED MICROTURBINE SYSTEMS

THE RULE IS AVAILABLE AT THE NEW YORK CITY DEPARTMENT OF BUILDINGS WEB SITE:

http://www.nyc.gov/buildings

(a) General requirements. All microturbine systems shall comply with the following general requirements:

(1) **Description**.

(i) The Microturbine System shall include one or more combustion-based turbine-driven electrical generators with 500 kW or less capacity, natural gas compressing equipment, heat recovery devices, electrical power distribution devices, gas vents or chimneys and associated appurtenances.

(ii) Microturbine systems shall utilize natural gas at an inlet pressure to the system of not greater than 3 psig, and shall boost the gas pressure to an inlet pressure to the combustion device of greater than 15 psig within the unit or room enclosure. The entire high-pressure line, from the inlet to the compressor through to the combustor, shall conform to the requirements for a gas train as defined in NFPA 37, 2006 Edition, Section 3.3.5.

(iii) The total nominal electrical capacity at standardized operating conditions of all microturbine systems located within a single building shall not exceed 2,000 kW.

(2) **Listing or MEA approval.** For microturbines with external compressors, the compressor shall be MEA-approved and all components of the compressor and the microturbine shall be listed by a nationally recognized testing laboratory approved by the Commissioner. For microturbines with the compressor integrated with other elements into the unit, the integrated unit as well as each of its components shall be listed by a nationally recognized testing laboratory approved by the Commissioner.

(3) **Utility ruling.** The applicant shall consult the appropriate utility company regarding the characteristics of existing gas and electrical service to the site before installing the microturbine system. The applicant shall provide to the Department prior to plan approval either documentation from the utility company confirming that interconnect requirements have been preliminarily satisfied or an affidavit from the owner that there will be no interconnection with the electrical grid.

(4) **Filing and permit.** Plans for the complete microturbine system installation shall be approved by the New York City Department of Buildings and a work permit shall be obtained. A set of the approved plans shall be provided to the Fire Department.

(5) **Installation.**

(i) Regulation. Installation of microturbine systems shall be in accordance with all applicable requirements of the New York City Building Code, the New York City Electrical Code, and Reference Standards. NFPA 37 shall also apply, except where the Codes or these Rules are more restrictive. Such regulations include, but are not limited to the following: fuel gas piping, egress, fire protection, fire detection, electrical power, ventilation, and gas vent or chimney.

(ii) External compressor. For microturbines with an external compressor, the following requirements shall be satisfied:

A. Gas connections between the compressor and the turbine shall be solid-welded; no threaded joints shall be permitted.
B. A flame arrestor shall be installed upstream of the gas compressor to prevent flame propagating to the natural gas fuel distribution lines.
C. The length of gas piping connecting the gas compressor with the combustion device, both of which shall be in the same room, shall not exceed 12 feet.

(iii) Annunciation. All annunciations shall be provided locally and remotely to indicate any abnormal conditions in the system. The remote panel shall be located in a continuously supervised area on the premises.

(iv) Automatic gas shut-off. Gas supply to the microturbine shall be provided with an automatic shut-off valve that is activated by a malfunction alarm from any component of the microturbine system.

(v) Remote emergency gas shut-off. A motorized fail-in-place gas shut-off valve shall be located immediately after the branch connection providing dedicated service to the microturbine installation. The valve shall be manually controlled at the valve and remotely controlled both outside the door(s) to the microturbine room and at a supervised location. The motorized fail-in-place gas shutoff valve and the controls shall each be clearly identified with signage indicating "emergency gas shut-off to microturbine."

(vi) Fuel shut-off valve diagram. A diagram shall be conspicuously posted on any door or gate leading to a microturbine indicating the locations of all manual and automatic fuel shut-off valves.

(vii) Security. The microturbine shall be provided with adequate protection from theft, tampering and unauthorized use. Access to microturbine systems shall be restricted by locked doors but shall be readily accessible for maintenance, repair and Fire Department access. Microturbines shall be adequately protected from vehicle impact.

(viii) Manufacturer's requirements. All manufacturer's requirements and recommendations shall be satisfied.

(ix) Signage. Signage clearly stating "HIGH PRESSURE GAS" shall be posted on or in front of the microturbine or microturbine system, and on the outside of all doors accessing any microturbine room.

(x) Existing buildings. For installation of microturbines in existing buildings, a structural evaluation of the method of support of the microturbine system shall be performed by a licensed engineer. Vibration isolation shall be provided for the microturbine system as required to mitigate vibration impact on the building structure.

(6) **Inspection.** Gas piping serving the microturbine shall be inspected by the Department. No self-certification of inspection shall be permitted. The inspection shall include a pipe integrity pressure test of all distribution piping. Installation and assembly of all system components shall be subject to a controlled inspection, in accordance with Section 27-132 of the New York City Building Code. Gas will be turned on only after successful completion of all testing.

(7) **Fire Department permit.** A Fire Department permit is required to operate the equipment.

(8) **Fire Department Certificate of Fitness**. A certificate of fitness ("C of F") holder, as authorized by the Fire Department, shall be required on the premises during regular business hours. The C of F holder shall be trained by the manufacturer or his authorized agent to shut down the equipment in an emergency.

(9) **Service contract.** The owner shall obtain a service contract from the microturbine manufacturer or a service company qualified by the manufacturer upon approval of the microturbine installation, and shall maintain it during the life of the installation.

(b) Permitted locations

(1) **Outdoors at grade, on a roof or on a roof setback, within an integral weatherproof or lightweight enclosure acceptable to the manufacturer**, subject to the following:

(i) Clearances. All components of the microturbine system shall be located a minimum of 4 feet from a wall or parapet, 8 feet from any building opening, including any door, operable window or intake opening and 5 feet from any exhaust termination or chimney. All microturbine systems located at grade shall satisfy the following clearances:
   A. 50 feet from any subway entrance, exit, vent or other opening;
   B. 20 feet from any above-ground flammable or combustible liquid storage tank;
   C. 10 feet from any lot line, except 4 feet from any lot line in and adjacent to a manufacturing district;
   D. 5 feet from any vent or fill line of any flammable or combustible liquid storage tank;
   E. 5 feet from any parked motor vehicle.

(ii) Enclosure. All microturbine system components shall be contained within integral weather-proof enclosures pursuant to the listing of the device. The unit enclosure or the lightweight constructed enclosure shall be provided with a gas detection system with an alarm that annunciates in a supervised location. Equipment not directly associated with the microturbine system shall not be permitted in the same enclosure.

(2) **Within a dedicated Mechanical Equipment Penthouse classified as Occupancy Group D-2,** and subject to the following:

(i) Enclosure. The mechanical equipment penthouse shall be enclosed within 2-hour fire-resistance rated walls.

(ii) Fire suppression. The equipment room shall be fully sprinklered or provided with an equivalent fire suppression system acceptable to the Commissioner.

(iii) Mechanical ventilation. Mechanical ventilation shall be provided for the mechanical equipment penthouse at a rate sufficient to dissipate sensible heat released from the microturbine system in accordance with the manufacturer's recommendations, at a rate adequate to dilute the microturbine system rated flow rate of fuel gas below 25 percent of the lower flammability limit (LFL) of the fuel gas, or at an exhaust and make-up air rate of 80 times the maximum leakage rate of natural gas from the high-pressure system within the room at standard temperature and pressure based on the rated capacity of the gas compressor, whichever is greater. The ventilation rate shall not be less than required to maintain the ambient room temperature within the manufacturer's recommendations but shall not exceed 104 degrees Fahrenheit. Proper distribution of exhaust and make-up air must be provided to prevent pockets of increased gas concentration, including exhaust points high in the room to address the lighter-than-air properties of natural gas. Mechanical ventilation shall operate continuously.

(iv) Gas detection and alarm. The mechanical equipment penthouse shall be provided with a gas detection system with an alarm that annunciates in a supervised location.

(v) Lighting. The mechanical equipment penthouse shall be provided with adequate lighting in accordance with the New York City Building Code.

(vi) Other equipment. Equipment not directly associated with the microturbine system, including but not limited to gas meters, shall not be permitted within the mechanical equipment penthouse.

(vii) Storage. No combustible materials shall be stored in the mechanical equipment penthouse.

(3) **Within a dedicated room in a building,** subject to the following:

(i) Capacity. The total installed rated capacity of the microturbine system in the room shall not exceed 1,000 kW.

(ii) Enclosure. The microturbine room shall be enclosed within 2-hour fire-resistance rated walls.

(iii) Fire suppression. The equipment room shall be fully sprinklered or provided with an equivalent fire suppression system acceptable to the Commissioner.

(iv) Mechanical ventilation. Mechanical ventilation shall be provided for the microturbine room at a rate sufficient to dissipate sensible heat released from the microturbine system in accordance with the manufacturer's recommendations, at a rate adequate to dilute the microturbine system rated flow rate of fuel gas below 25 percent of the lower flammability limit (LFL) of the fuel gas, or at an exhaust and make-up air rate of 80 times the maximum leakage rate of natural gas from the high-pressure system within the room at standard temperature and pressure based on the rated capacity of the gas compressor, whichever is greater. The ventilation rate shall not be less than required to maintain the ambient room temperature within manufacturer's recommendations but not to exceed 104 degrees Fahrenheit. Proper distribution of exhaust and make-up air must be provided to prevent

pockets of increased gas concentration, including exhaust points high in the room, to address the lighter-than-air properties of natural gas. Mechanical ventilation shall operate continuously.

(v) Gas detection and alarm. The microturbine room shall be provided with a gas detection system with an alarm that annunciates in a supervised location.

(vi) Lighting. The microturbine room shall be provided with adequate lighting in accordance with the New York City Building Code.

(vii) Other equipment. Equipment not directly associated with the microturbine system, including but not limited to gas meters, shall not be permitted within the microturbine room.

(viii) Storage. No combustible materials shall be stored in the microturbine room.

(b) Within a boiler or other mechanical equipment room of a building, subject to the following**:**

(i) Capacity. The total installed rated capacity of the microturbine system in this room shall not exceed 500 kW.

(ii) Enclosure. The mechanical equipment room shall be enclosed within 2-hour fire-resistance rated walls.

(iii) Fire suppression. The mechanical equipment room shall be fully sprinklered or provided with an equivalent fire suppression system acceptable to the Commissioner.

(iv) Mechanical ventilation. Mechanical ventilation shall be provided for the mechanical equipment room at the rate sufficient to dissipate sensible heat released from all gas-burning equipment located within the mechanical equipment room in accordance with the microturbine manufacturer's recommendations, at a rate adequate to dilute the microturbine system rated flow rate of fuel gas below 25 percent of the lower flammability limit (LFL) of the fuel gas, or at an exhaust and make-up air rate of 80 times the maximum leakage rate of natural gas from the high-pressure system within the room at standard temperature and pressure based on the rated capacity of the gas compressor, whichever is greater. The ventilation rate shall not be less than required to maintain the ambient room temperature within the manufacturer's recommendations but shall not exceed 104 degrees Fahrenheit. Proper distribution of exhaust and make-up air must be provided to prevent pockets of increased gas concentration, including exhaust points high in the room, to address the lighter-than-air properties of natural gas. Mechanical ventilation shall operate continuously.

(v) Gas detection and alarm. The mechanical equipment room shall be provided with a gas detection system with an alarm that annunciates in a supervised location.

(vi) Lighting. The mechanical equipment room shall be provided with adequate lighting in accordance with the New York City Building Code.

(vii) Gas meters shall not be permitted within the mechanical equipment room.

(viii) Storage. No combustible materials, including fuels, shall be stored in the mechanical equipment room.