Revised on 7/19/2016

FIRE DEPARTMENT • CITY OF NEW YORK

STUDY MATERIAL
FOR THE

CERTIFICATE OF FITNESS EXAMINATION
G-91
Supervision of Natural Gas
Co-generation System

*Note 1:

The G-91 COF is only required for co-generation equipment that (1) Uses natural gas distribution piping designed for or operated at 15 psig or greater or (2) utilizes natural gas that is compressed on-site to a pressure exceeding 6 psig.

*Note 2:

G-29 is part of g-91 exam. It is recommended that g-29 study material be read and understood prior to taking g-91 exam. G-29 may have sections which were described in this study material.

INSIDE THIS BOOKLET YOU WILL FIND THE FOLLOWING:

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

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NOTICE OF EXAMINATION

Title: **Examination for Certificate of Fitness for Supervision of Natural Gas Co-generation Systems (G-91).**

Date of Test: Written tests are administered Monday through Friday (except legal holidays) at **2:45PM**: by **appointment only**. Starting processing time for a test is **2:45 PM**. No test will be administered to applicants who arrive after the **3:00 P.M**. To schedule an individual or group appointment please email pubcert@fdny.nyc.gov and/or call 718-999-1988, 718-999-1986.

TEST SITES: Written tests are conducted at 9 Metro Tech Center, Brooklyn, NY, 11201.

QUALIFICATION REQUIREMENTS

1. Applicants must be at least 18 years of age.
2. Applicants must have a reasonable understanding of the English language.
3. Applicant must provide two forms of identification; and at least one form of identification must be government issued photo identification, such as a State-issued Driver's License or Non Drivers License or a passport.
4. Applicants must submit a completed application for Certificate of Fitness (A-20 Form). http://www1.nyc.gov/assets/fdny/downloads/pdf/business/cof-application-form.pdf
5. Applicants not currently employed may take the exam without the recommendation letter. If the applicants pass the exam, FDNY will issue a temporary letter with picture for the job seeking purpose. The C of F card will not be issued unless the applicants are employed and provide the recommendation letter from his/her employer.
6. Special requirements for the G-91 Certificate of Fitness:
   (1) Applicants must submit a letter of recommendation **from his/her employer**. The letter must be on official letterhead, and must state the applicant's full name, experience and the address where the applicant will work. Letters must also include the type of Co-Gen system installed in the plant. The employer shall include that this employee has the appropriate training to operate the Co-Gen equipment and systems which are at the facility.
   See APPENDIX (at the end of this study material) for a sample of employer recommendation letter.

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(2) Applicants must submit written evidence of training by the **manufacturer** for the specific cogeneration system as well as safety procedures for the equipment installed at the COF applicants' work place(s). System that's on the completion certificate **must** match system described by employer (see 6.(1) above).
(3) Applicants shall submit a copy of minimum: a high school diploma, or its educational equivalent, approved by a state's Department of Education, or an approved accrediting organization.
(4) Applicant should have minimum 1 year of full-time experience in mechanical building or plant systems.

7. APPLICATION FEE:

Pay the **$25** application fee in person by one of the following methods:

- Cash
- Credit card (*American Express, Discover, MasterCard, or Visa*)
- Debit card (*MasterCard or Visa*)
- Personal or company check or money order (*made payable to the New York City Fire Department)*

For fee waivers submit: ***(Only government employees who will use their C of F for their work- related responsibilities are eligible for fee waivers.)***

- A letter requesting fee waiver on the Agency's official letterhead stating applicant full name, exam type and address of premises; ***AND***
- Copy of identification card issued by the agency

A convenience fee of 2.49% will be applied to all credit card payments.

8. **EXAM INFORMATION**

The G-91 test will consist of **75** multiple-choice questions, administered on a "touch screen" computer monitor. It is a time-limit exam. Based on the amount of the questions, you will have 112 minutes to complete the test. A passing score of at least 70% is required in order to secure a Certificate of Fitness.

***G-29 IS PART OF G-91 EXAM. IT IS RECOMMENDED THAT G-29 STUDY MATERIAL BE READ AND UNDERSTOOD PRIOR TO TAKING G-91 EXAM. G-29 MAY HAVE SECTIONS WHICH WERE DESCRIBED IN THIS STUDY MATERIAL.**

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WEBSITE
Please always check for the latest revised booklet at the FDNY website before you take the test. The Certificate of Fitness Study Material can be found at the link below:
http://www1.nyc.gov/assets/fdny/downloads/pdf/business/cof-g91-noe-study-materials.pdf

RENEWAL REQUIREMENTS

This Certificate of Fitness must be renewed every ***THREE YEARS***. The renewal fee is **$15**. FDNY also reserves the right to require the applicants to take a re-examination upon submission of renewal applications.

You will receive a courtesy notice of renewal 90 days before the expiration date. However, it is your responsibility to renew your Certificate. It is very important to renew your C of F before it expires. Renewals submitted 90 days (up to one year) after the expiration date will incur a $25 penalty in addition to the renewal fee. Certificates expired over one year past expiration date will not be renewed. New exams will be required.

To change a mailing address:
- Submit a letter requesting the change of mailing address and a copy of your C of F with $5.00 fee.

To change a work location,
- Submit a letter from your current employer (on company letterhead) confirming that you are an employee and stating your new work location with a copy of your C of F and a $5.00 fee

To request a replacement certificate:
- Submit a driver's license or passport, social security number, mailing address and a $5.00 fee.

The certificate can be renewed **On-line**, **by Mail** or **in Person**.

- **Renewal online**

If you are an individual, make sure you have your 12 digit Certificate of Fitness Access ID. This can be found on your Renewal Notice. If you do not have your Renewal Notice, your Access ID is your 8 digit Certificate of Fitness number and the last four digits of your social security number. If you are submitting renewals on behalf of a company's employees, the company must be approved by FDNY and have an 8 digit Company Code. To request approval, email pubrenew@fdny.nyc.gov.

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Renewal fee can be paid by one of the following methods:

- Credit card (American Express, Discover, MasterCard, or Visa)
- Debit card (MasterCard or Visa)
- E-check

A fee exempted applicants cannot renew online only by mail or in person.

If all the requirements are met, the certificate of fitness will be mailed out within 10 days.
For online renewal go to: **https://a836-citypay.nyc.gov/citypay/FDNYCOF**

- **Renewal by mail**

Mail your Renewal Notice (if you did not receive a Renewal Notice, a copy of your certificate), along with your fee payment

Personal or company check or money order (made payable to the NYC Fire Department)

For fee waivers submit: ***(Only government employees who will use their C of F for their work- related responsibilities are eligible for fee waivers.)***

- A letter requesting fee waiver on the Agency's official letterhead stating applicant full name, exam type and address of premises; ***AND***
- Copy of identification card issued by the agency

and if applicable, supporting documents to:

NYC Fire Department (FDNY)
Cashier's Unit
9 MetroTech Center, 1st Floor
Brooklyn, NY 11201

If all the requirements are met, the certificate of fitness will be mailed out within four to six weeks.

- **Renewal in person**

Submit your Renewal Notice (or if you did not receive a Renewal Notice, a copy of your certificate), along with your fee payment by one of the following methods:

- Cash
- Credit card (*American Express, Discover, MasterCard, or Visa*)
- Debit card (*MasterCard or Visa*)
- Personal or company check or money order (*made payable to the New York City Fire Department)*

For fee waivers submit: ***(Only government employees who will use their C of F for their work- related responsibilities are eligible for fee waivers.)***

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- A letter requesting fee waiver on the Agency's official letterhead stating applicant full name, exam type and address of premises; ***AND***
- Copy of identification card issued by the agency and if applicable, your supporting documents to:

  NYC Fire Department (FDNY)
  Cashier's Unit
  9 MetroTech Center, 1st Floor
  Brooklyn, NY 11201

If all the requirements are met, the certificate of fitness will be issued the same day.

A convenience fee of 2.49% will be applied to all credit card payments for original or renewal certificates.

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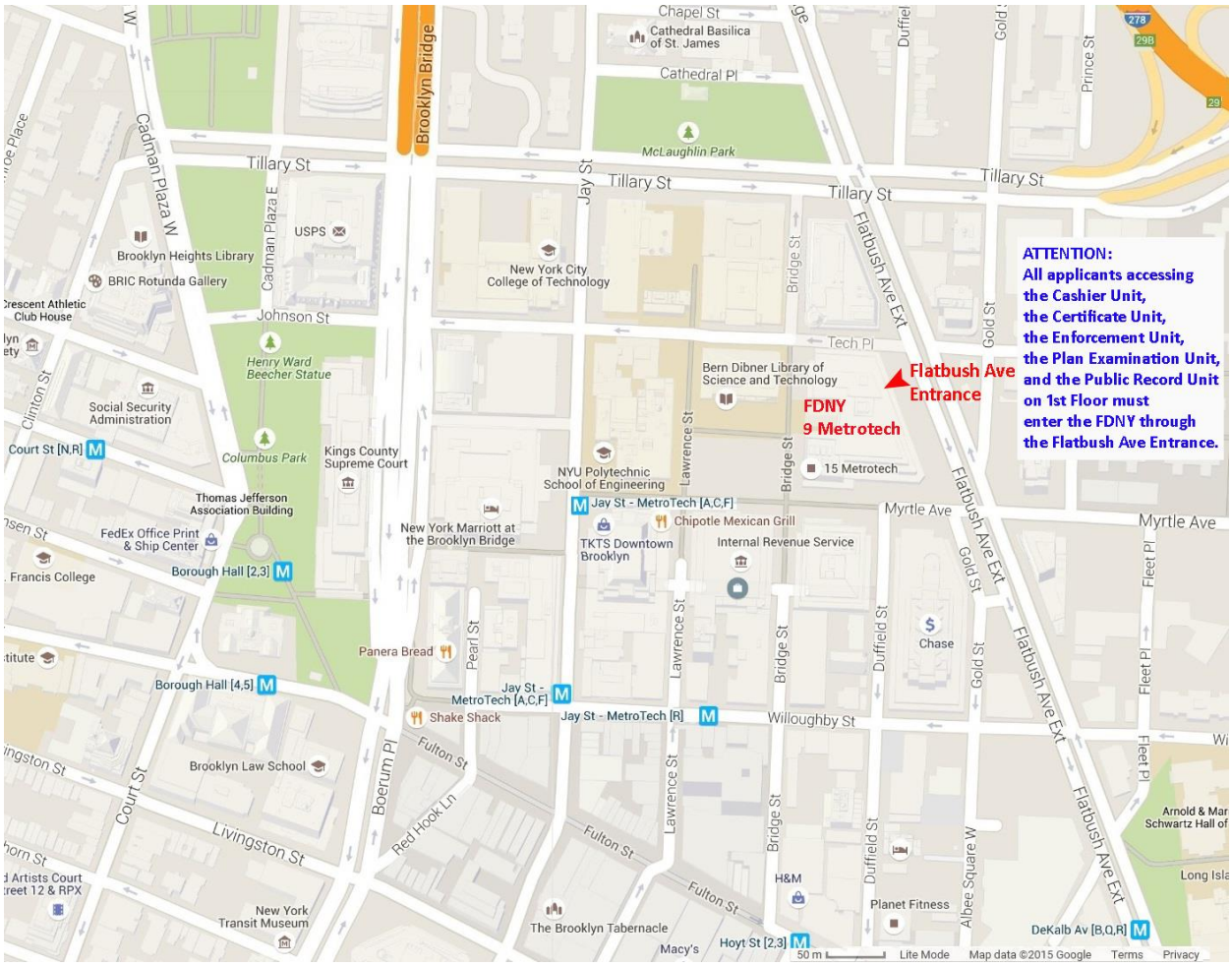
<u>EXAM SITE</u>: FDNY Headquarters, 9 MetroTech Center, Brooklyn, NY. Enter through the **Flatbush Avenue entrance (between Myrtle Avenue and Tech Place)**.



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STUDY MATERIAL AND TEST DESCRIPTION

ABOUT THE STUDY MATERIAL

The study material will help the applicant prepare for the written examination for the Certificate of Fitness for Supervision of Natural Gas Co-Generation Systems.

This study material **does not** contain all the information you need to know to work with a Co-Gen system. 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

Which of the following are allowed to be used while taking a Certificate of Fitness examination at 9 Metro Tech Center?

I. cellular phone
II. study material booklet
III. reference material provided by the FDNY
IV. mp3 player

A. III only
B. I, II, and III
C. II and IV
D. I only

Only reference material provided by the FDNY is allowed to be used during Certificate of Fitness examinations; therefore, the correct answer would be “A”. You would touch “A” on the computer terminal screen.

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If the screen on your computer terminal freezes during your examination, who should you ask for help?

A. the person next to you
B. the firefighters
C. the examiner in the testing room
D. the computer help desk

If you have a computer related question, you should ask the examiner in the testing room; therefore, the correct answer would be “C”. You would touch “C” on the computer terminal screen.

If you do not know the answer to a question while taking an examination, who should you ask for help?

A. the person next to you
B. the firefighters
C. the examiner in the testing room
D. you should not ask about test questions since FDNY staff can not assist applicants

You should not ask about examination questions or answers since FDNY staff cannot assist applicants with their tests; therefore, the correct answer would be “D”. You would touch "D" on the computer terminal screen.

Special Recognition is given to all parties involved in the creation of this document especially LZ Cornell ’16.

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CERTIFICATE OF FITNESS RESPONSIBILITIES AND DUTIES

Certificate of Fitness holders should be aware that they may be required to demonstrate their knowledge and proficiency in their duties related to their certificate at the time of original and renewal application, and at any time Fire Department representatives are conducting an inspection of the premises. The Fire Department can deny, not renew, suspend or revoke a certificate for misconduct, which would include the failure of the certificate holder to properly fulfill his or her duty for any reason.

The Certificate of Fitness holder must keep the Certificate of Fitness upon his or her person, or otherwise readily available for inspection by any representative of the Department, at all times while operating or supervising a Co-Gen plant for which the certificate is required.

In addition to any other penalties provided by law, misconduct on the part of an applicant or holder of a Certificate of Fitness shall be grounds for denial, non-renewal, suspension or revocation of a certificate, and denial of an application for a certificate or the opportunity to take a certificate examination. Such misconduct includes, but is not limited to:

- The failure of certificate holders to properly fulfill their duties
- Any false and fraudulent conduct in connection with an application for a certificate or the duties of a certificate holder, including:
    - False or fraudulent statements or submissions
    - Unauthorized changes to or use of a certificate or possession of a fraudulent certificate
    - Cheating on an examination
    - Impersonating another person or allowing oneself to be impersonated

- The failure of certificate holders to promptly notify the Fire Department of any change in the applicant's or certificate holder's residence address, or work location
- Any other conduct that decreases the integrity or reliability of an applicant or certificate holder
- Compromising the integrity or confidentiality of a Fire Department examination

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

1. INTRODUCTION TO COGENERATION SYSTEM

Cogeneration is the process whereby a fuel source, such as natural gas or liquid fuel, is used to produce both electrical and thermal energy. Cogeneration operates on a very basic principle: Generating electricity and producing heat. Cogeneration equipment captures that heat and uses it to supply hot water, steam, space heating and/or cooling.

Unfortunately, just as any occupation that focuses on working with fuel, gas, or electricity, a Co-Generation plant may also pose several hazards. Those hazards, may result in, but not limited to the following:

- Fire
- Explosion
- Asphyxiation
- Dangerous sound levels
- Rotating and moving equipment
- High voltage electricity
- High temperature burns

The owner of the premises must obtain a permit from the NYC Fire Department prior to the operation of the Co-Gen system. Permit applications shall be filed with the Fire Department's Bureau of Fire Prevention at Fire Department Headquarters. The permit application shall include the 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 Co-Gen system. **The Bureau may require more information should it see the need for it.**

***All required Fire Department permits and Certificates of Fitness must be obtained prior to operation of a Co-Gen system, and the copies of the permits and Certificate of Fitness forms shall be CONSPICUOUSLY posted on the premises.**

A co-generation system may be comprised of electrical power generation and distribution, heating, cooling, and control systems. It has numerous components, and proper safety precautions and operating measures must be taken by individuals that are working on, and around these systems. Certificate of Fitness holders have to be diligent and take care in the operation of these systems to protect the public as well as themselves, the equipment, and the property around them.

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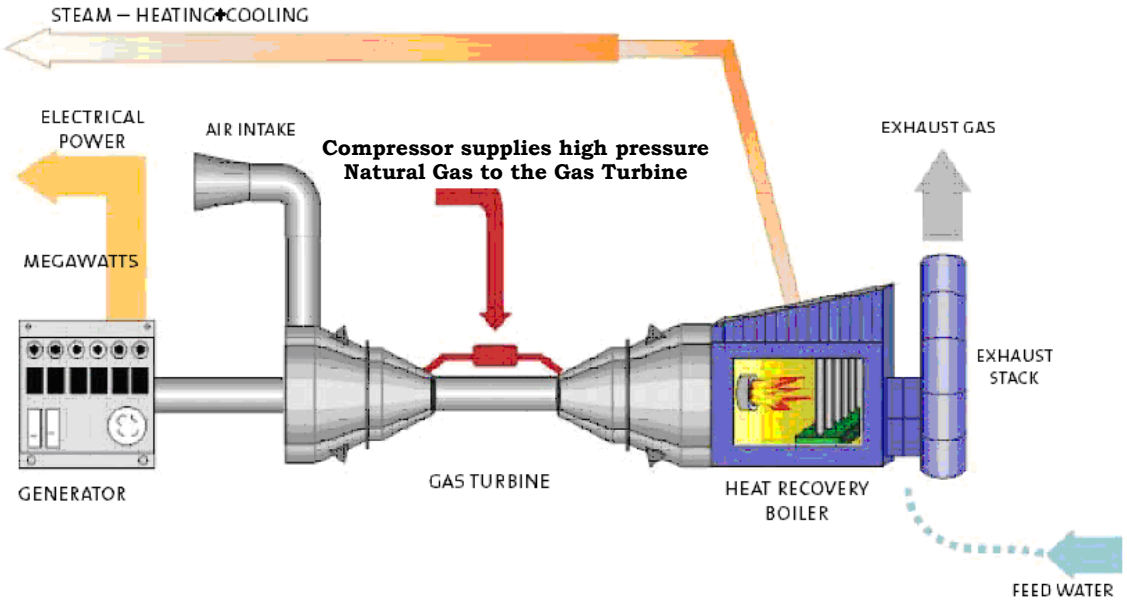
Engine generators in co-generation plants can consist of several types and sizes. The operators must be familiar with the entire Co-Gen and be fully trained on the equipment of which they are in charge of and of which they have obtained the appropriate certificate of fitness for. It is the responsibility of the owner to provide the proper training.

The operator's training must include:

- Overview of the Co-Gen with the plant manager, and reviewing details regarding operation and supervision.
- Sending the Certificate of Fitness holder to the manufacturer for training, or having the manufacturer/equipment representative on the premises to provide proper training.
- Familiarity with safety regulations and emergency plans, and how to access and maintain them.
- Additional training or refresher courses to ensure safe and proper operations.

Different Co-Gen systems may be comprised of different components; however, all Co-Gen systems involve the use of common equipments - such as pumps, valves, filters, turbines, compressors, and generators.



COGENERATION SYSTEM DIAGRAM

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2. PROCESS DESCRIPTION

2.1) COOLING SYSTEMS

The Co-Gen installations become heated during operation; it is important that heat is removed by the cooling system. Cooling is crucial to the system and without this working properly, important components of the Co-Gen will not be able to operate properly and can result in overheating, shutdown and potential damage of property. Do not treat a failed pump, loose parts, noisy belt, unusual vibration, or leaks lightly. Cooling the machine prevents overheating and increases the efficiency of the system. The cooling system can be used to cool down cooling media, such as glycol mix, that cools gas compressor gas, turbine, and the lubricating oil system. Some systems have additional heat exchangers to help the cooling.

Typical Cooling Water Pumps

2.1.1) Open Cooling System

Cooling may be in the form of an open cooling system, such as a cooling tower, where make-up water is needed as water evaporates. Make-up water can be from the river or city water. The water needs to be chemically treated and tested during every watch. A chemical control and blowdown system monitors the amount of dissolved solid that accumulates, which needs to be removed to avoid blocking flow or impairing operations.

Cooling tower systems should be automatic control “Auto” to ensure the automatic start and stop of the pumps. **Proper water levels must be maintained in the sumps and systems to prevent damage to equipment.**

2.1.2) Closed loop cooling systems are linked to a cooling tower or a heat exchanger. They do not require continuous make-up water as the

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closed loop water is cooled by an open cooling system or heat exchanger. Examples include a chiller, dry cooler, or heat exchanger. The cooled liquid is circulated to cool air or equipment as required. The system is filled with a water/glycol mixture which is continually circulated. Glycol is used as anti-freezing agent. When performing maintenance on the closed loop system, all glycol may be put back into the additional tank for re-use after it is inspected that it is clean.

Closed loop cooling systems must also maintain proper system pressure, levels, and pressures and make up systems should be monitored daily to ensure a safe working system.

2.1.3) Winter Operations of Cooling Systems
Glycol is used as anti-freezing agent to ensure that circulating water does not freeze. The cooling systems and their sumps are often equipped with a heater for cold weather operation. Operation of sump heaters and other controls, such as low water cut off switch, will keep the heater from operating if the water level is too low to provide cooling to the heating element.

2.1.4) System flow monitoring
Co-Gen installations have different types of flow control devices such as circuit setters, flow meters and control valves. Flow rates should be monitored to ensure proper cooling water flows to system and equipment. Devices such as circuit setters should be checked every year to make sure they are properly balanced.

2.1.5) Expansion Tank and System is filled with water/glycol mix for cooling water. The mixture is set based upon the coldest operating condition. These systems are often filled by the mix and pump or dosing system. Once proper mix is achieved further addition of water may cause freeze ups in system because of cold weather conditions. The mixture of glycol in these systems should be verified before each cold weather season starts.

Expansion Tank

The expansion tank is needed to handle the change in volume of the system as it goes through its temperature changes and its resultant expansion and contraction because of changes in specific volume of fluids. This should **NEVER** be valved off during the operation.

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2.2) LUBRICATING (LUBE) OIL SYSTEMS

Lubrication systems deliver controlled amount of lubricant, such as oil, to multiple, specific locations on a machine, while it is operating at specific time intervals. This helps reduce friction and wear in the system, help sealing for gases, exchange heat, prevent corrosion, etc. This allows lubricant to be distributed evenly across the bearing because it is injected when it is operating, and allows critical components to be lubricated more effectively regardless of ease of access, and safely by not needing manual lubrication. Lube oil gets heated when circulating and needs to be cooled. Lubrication systems may be found in the gas compressor, turbine, and other machines.

Lube oil and lube oil filters need to be replaced from time to time, and smell strongly of gas. It is recommended that the filters and components are first purges, or be changed at night or at a time when few people will be alarmed by the smell. Lube oils should be stored properly and away from combustible or incompatible materials. Lube oil usually comes in 55 gallon cylinders and needs proper protection, such as not being stored for too long or near electrical rooms. Do not accept lube oil if the plant has irregular conditions because it might cause a hazard if it is stored at the plant.

2.3) GAS METER ROOM

The gas meter room contains the gas train and gas detection system. This is where the natural gas is piped in from the supplier and used to run parts of the Co-Gen. The plant operators have to duty to monitor the operation of the entire natural gas system for leaks, maintenance issues, high and low pressure conditions and ambient methane levels as indicate by gas detectors. The door should be properly labeled indicating hazards.

Example of Warning Sign outside the Gas Meter Room

2.3.1) Gas Train

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The gas train is a series of pipes and valves that carry a gaseous fuel supply from a supplier, such as ConEd, and supplies the fuel to the gas compressor, and possibly to the duct burner of the Heat Recovery Steam Generator (HRSG). Depending on the pressure of the natural gas from the supplier, the fuel supplied to the compressor may be compressed for the gas turbine, and the fuel supplied to the duct burner may go through a pressure reducing valve to a lower pressure for supplemental firing.

The main components of the **GAS TRAIN** include:

- **Filter**, which filters the gaseous fuel for small particles or excessive liquid to protect delicate parts and prevent clogging.
- **Meter**, which reads the amount of gas coming in from the supplier.
- **Shut-off valves**, which shut off the gas supply in case of system malfunction or when a detector or alarm activate. There are manual and automatic shut-off valves. These valves must be clearly labeled.
- **Meter By-pass valve**, when fuel bypasses the gas meter during maintenance and the amount of gas used is not recorded. Operations on this component can only be performed by the gas supplier.
- **Vent valve**, which is used to relieve gas build-up. It is extremely hazardous for large quantities of gas to be released into the atmosphere. Appropriate precautions must be taken to limit the gas that is released into the atmosphere. The operator must be aware of the vent location, vent rate, and impact on the environment to avoid creating a nuisance and hazardous conditions.

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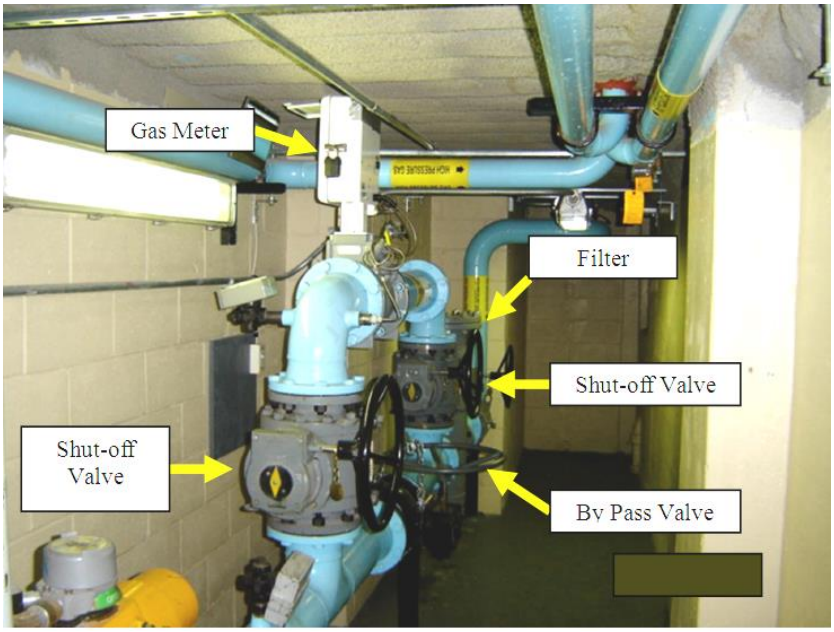

A Gas Train in a Gas Meter Room

2.3.2) Gas Detection System

The NYC Building Code requires that any gas line above 15psi be routed through a machinery room be doubled walled and the annular space be monitored for gas. This pipe-in-pipe system measure is for an emergency. In case there is ever a pipe rupture, it is designed to resist potential gas explosions. Natural gas system sensors in the plant need to monitor the air for hazardous concentrations of natural gas near the LEL, where ignition and explosion would occur. Both the pipe-in-pipe and ambient air system sensors are installed to act as a warning device(s) and shutdown control sensors.

Gas detection system for the Co-gen plant shall be installed in accordance with and operated with approved applicable standards and codes specific to each site. **Gas detection systems must be maintained and monitored on a regular basis. Operators must be familiar with the procedures for identifying and responding to gas alarms. The detectors must be calibrated quarterly, semi-annually or annually based upon manufacturer's recommendations and as stated in the Cogeneration approval letter issued by the FDNY to the owner of the high pressure gas facility.**

Gas Detectors

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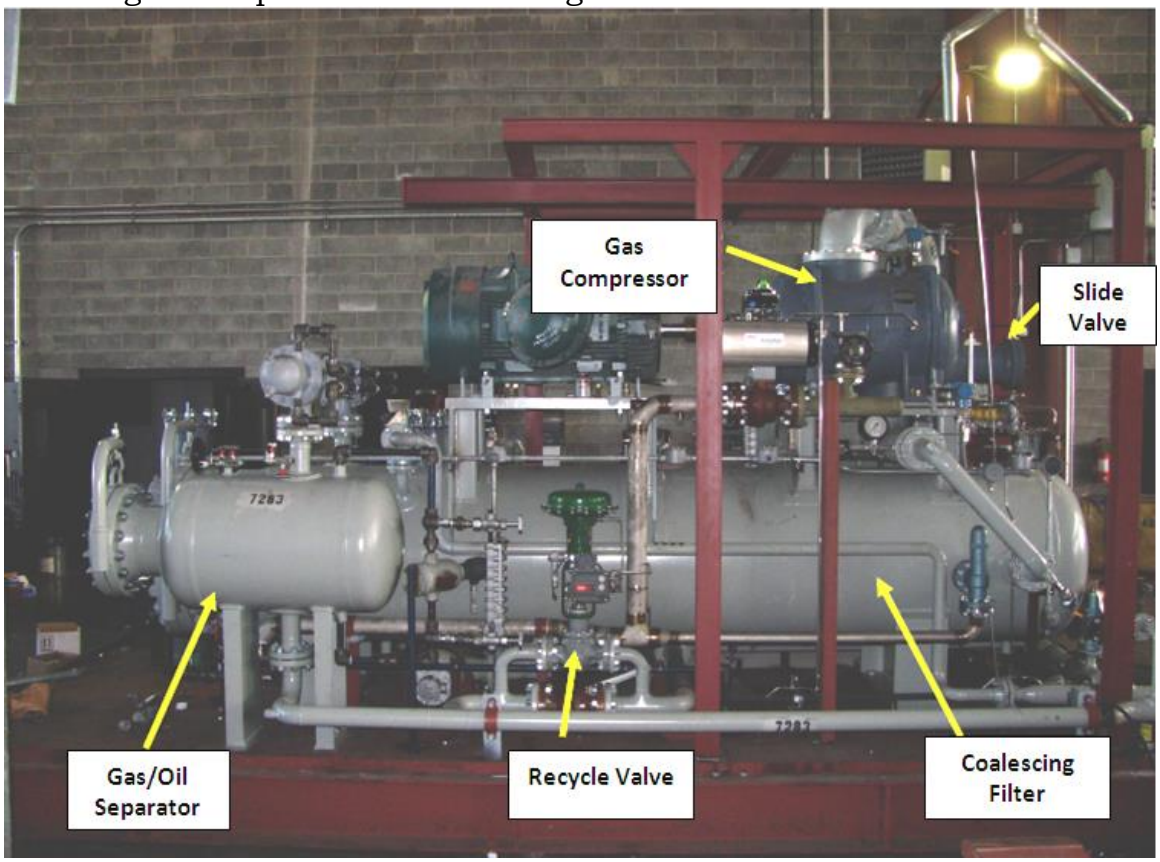
2.4) GAS COMPRESSOR

The purpose of a gas compressor is to increase the pressure of the natural gas delivered to the combustor of the turbine. The gas feeding into the gas compressor comes from the gas train. There are different types of compressor depending on the manufacturer and the machine model for different installation requirements and needs. Examples include centrifugal, axial, reciprocating, rotary compressors. The compressor compresses the gas to a psi required by the turbine or engine. Compressing the gas will increase the temperature, therefore, proper cooling may be required. Proper lubrication is needed as well.

Example of Warning Sign outside the Gas Compressor Room

It is also important to know that the compressor room shall have the appropriate signs indicating high pressure gas, with proper noise-reducing and explosion withstanding doors.



Gas Compressor Room

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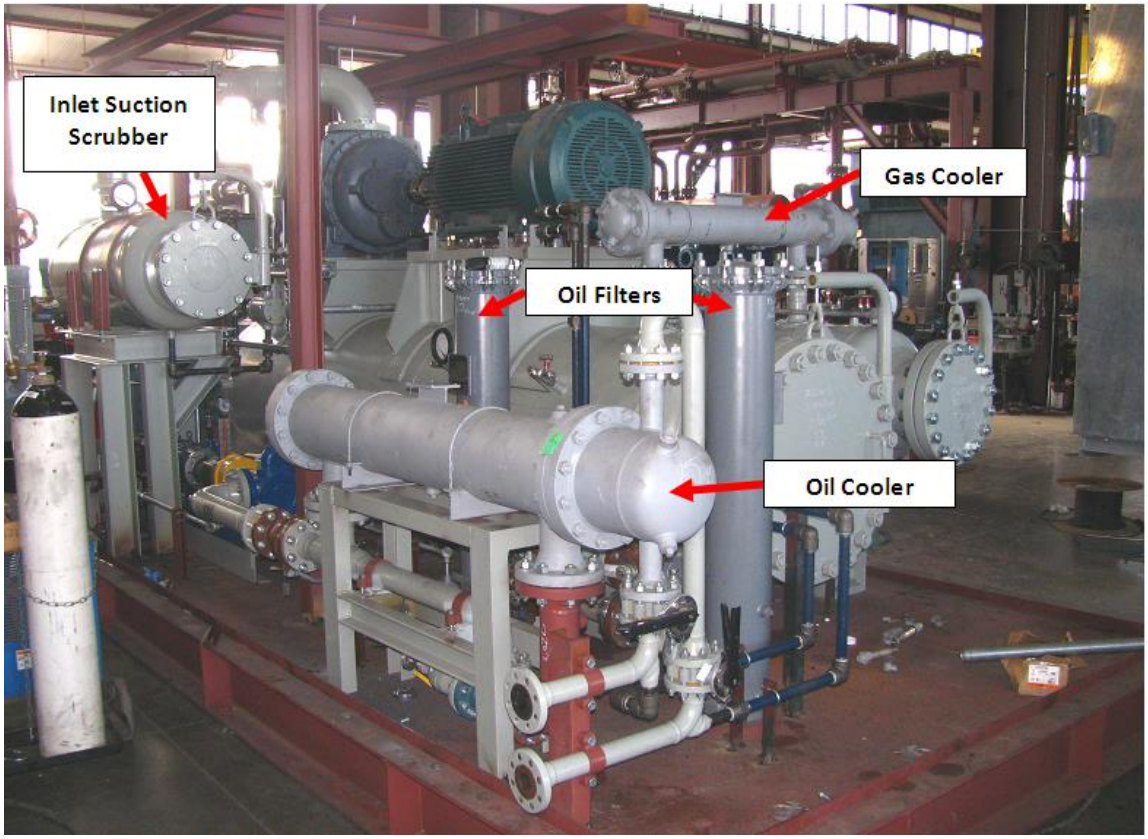

Gas Compressor Room

2.4.1) Components of the Gas Compressor Room

The **inlet expansion tank** on the inlet is where the gas enters the compressor via the pipeline from gas supplier such as Con Ed. This allows for sufficient supply of gas to the compressor on start up and to collect any moisture that might be in the gas as it enters the system.

The **suction scrubber** removes particulates and condensable liquids in the gas line before the gas enters the gas compressor.

Inlet and outlet valves allow gas to enter and exit the compressor. They are held open by air pressure. If there are any issues, the valves will cycle closed. They are a fail-close valve; so any break in power to the air solenoids or air lines also closes the valves.

Slide Valve is part of the internal workings of the compressor. It is part of the casing that slides back and forth under the discharge end of the compressor to change the volume ratio of the machine. That allows the unit to compress more or less volume as needed by the system.

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Recycle valve controls outlet gas pressure by recycling gas back to the inlet of the gas compressor. This is done to control the outlet gas pressure of the compressor skid to the turbine.

Vent Valve is a valve that should only be opened in emergency situations where venting the gas off the compressor is necessary. The vent valve is installed as a venting device for the skid, located a safe distance away from building openings. It is extremely hazardous for large quantities of gas to be released into the atmosphere. Appropriate precautions must be taken to limit the gas that is released into the atmosphere. This valve can only be opened if the main gas valve is off, and the compressor is not running, usually during maintenance. The operator must be aware of the vent location, vent rate, and impact on the environment to avoid creating nuisance and hazardous conditions. Vent valves may be provided with flame arrestors.

Discharge Separator Tank on Outlet of Gas Compressor
The discharge from the gas compressor is a mixture of gas and lube oil. The gas is separated from oil by means of a filter, such as a **coalescing filter**. If oil starts to carry over it becomes an issue for the turbine, and the filter needs to be checked. The filter in the separator should be changed in accordance to the manufacturer's instructions. When changing filters, the filter may have a strong smell of natural gas. **Gas cooler** may be used to reduce the temperature of the gas enough to drop out any oil that is still left in suspension at the coalescing filter. The bottom half of this tank is the oil reservoir for the system. This oil level must be monitored frequently. Oil is pushed by gas pressure through the cooling system, the filters, and then back into the compressor. An **after cooler** may be used to reduce the temperature of the gas, which is heated up during compression, and to squeeze out any water that may be in the natural gas pipe line from the gas supplier.

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A Gas-Lube Oil Separator

Monitoring Oil Level in Separator Tank

2.4.2) Gas Compressor Enclosure Gas Detection System and Fire Detection Systems

All gas compressor enclosures are considered hazardous areas. The electrical area classification is typically a Class 1 Division 2 hazard. This classification requires explosion proof fixtures and controls. Great care should be taken not to disturb the electrical or control wiring, boxes or lighting fixtures. Natural gas should never be introduced into the system when any of these systems are open or under maintenance. Any maintenance of these systems requires an approved NFPA 56 “Gas Purge out and Purge in” procedure. Maintenance of the flame, fire and gas detection services are required to be kept in good working order in line with manufacturer’s recommendations. Equipment operators shall be aware and keep up to date on all operating and maintenance requirements of all equipment within system.

Turbine-generators enclosures usually have a suppression system (CO2, water-mist) installed. Suppression system plays an important role if a fire or gas is detected. If the fire detection system is activated, the unit shuts down and the valves shut.

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2.5) GAS TURBINE OR ENGINE

A gas turbine is an internal combustion engine that operates with rotary motion. Gas turbines are essentially composed of three major components: **air 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 compressed natural gas is introduced, ignited, and burned. The combustion produces a fireball of energy that rotates the turbine, which powers the generator and produces electricity.

Sometimes, an engine converts energy to useful mechanical motion, such as a reciprocating engine. The mechanical energy then powers to the generator to produce electricity. Examples include an internal combustion engine, a steam engine, or Stirling engine. The internal combustion engine works similar to a gas turbine by combusting fuel and air to produce high-temperature and high-pressure gases that have energy to move a piston or turn a power turbine. The steam engine uses steam, such as those produced in the Heat Recovery Steam Generator or boiler, to produce mechanical motion. An example would be the steam turbine. **The operations of steam turbines are performed under a steam operator's license because of high pressure steam.**

The gas turbine, or engine, is loud, hot, contains flammable and hazardous gases, and rotates at very high speeds. Proper enclosure and warning signs shall be posted to indicate the hazard, shut-off devices, and safety and emergency protocol. Safety monitoring devices must be in working order.

Exhaust ducts can reach high temperatures, which would cause severe burns and injuries if touched; it can also cause fires if in contact with combustible and flammable material. The duct outlets shall be allowed to discharge the hot exhaust gases. Keep in mind that the hazard from leaks and exhaust gases may cause carbon monoxide poisoning and burns. Warning signs shall be posted to instruct where it is dangerous and precautions must be taken. The integrity of the high temperature insulation around the exhaust ducts penetrating walls or roofs shall be verified periodically.

Exhaust Duct at a Co-Generation Plant

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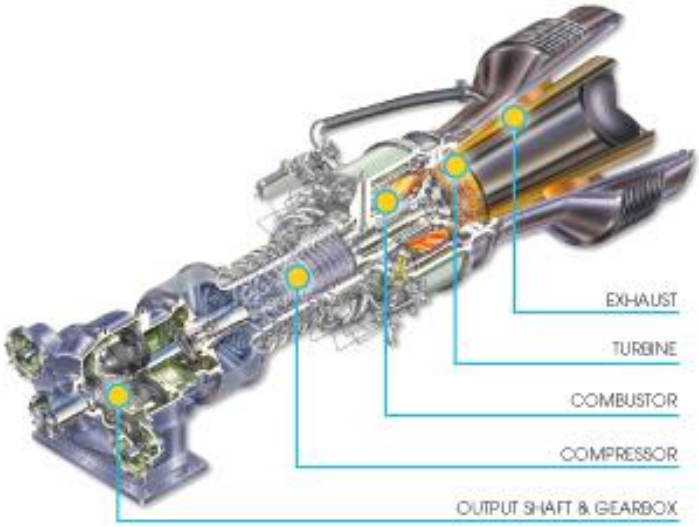
Basic Component of a Gas Turbine



Single Shaft Gas Turbine

Air Compressor
The compressor takes in outside air, filters it, and then compacts and pressurizes the air molecules through a series of rotating and stationary compressor blades.

Combustor
In the combustor, compressed fuel is added to the pressurized air molecules and ignited. The heated molecules expand and move at high velocity into the turbine section.

Power Turbine
The turbine converts the energy from the high velocity gas into useful rotational power though expansion of the heated compressed gas over a series of turbine rotor blades.

Output Shaft & Gearbox
Rotational power from the turbine section is delivered to driven equipment through the output shaft via a speed reduction gearbox. The mechanical energy will connect to a generator which produces electricity.

Exhaust
The engine's exhaust section directs the spent gas out of the turbine section and into the HRSG. Exhaust ducts can reach high temperatures, cause fire if in contact with combustible material, and hazardous leaks can cause gas poisoning.

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2.5.1) Engine or Turbine Enclosure

All gas engines enclosures are considered hazardous areas. The electrical area classification is typically a Class 1 Division 2 hazard. This classification requires explosion proof fixtures and controls. Great care should be taken not to disturb the electrical or control wiring, boxes or lighting fixtures. Natural gas must never be introduced into the system when any of these systems are open or under maintenance. Any maintenance of these systems requires an approved NFPA 56 "Gas Purge out and Purge in" procedure. Maintenance of this flame, fire and gas detection services are required to keep in good working order in line with the manufacturer's recommendations. Equipment operators shall be aware and keep up to date on all operating and maintenance requirements of all equipment within system.

Turbine Generators enclosures usually have a suppression system (CO2, water-mist) installed. A suppression system plays an important role if a fire or gas is detected. If the fire detection system is activated, the unit shuts down and the valves shut.

Gas Turbine-Generator Enclosure

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2.6) ELECTRIC GENERATOR

In electricity generation, an electric generator is a device that converts mechanical energy to electrical energy. A generator allows electric current to flow through an external circuit. The source of mechanical energy may be an internal combustion or turbine engine. Generators provide nearly all of the power for electric power grids. Some Co-Gen systems also may have steam turbines which also add generation capacity to the overall system.

The generator is located at one of the ends of a turbine. The generator looks like a cylinder shaft and is made of metal, usually copper, with cut forces of electrical field. The turbine's rotary mechanical energy spins the **rotor**. The rotor spins around a magnetic coil, which produces a magnetic field, and generates electricity. The electrical energy connects to the power grid and is used to power the building load. The amount of electricity generated is measured in kilowatt-hours (kWh), and can be read from the control screen near the generator and in the control room.

Generally, the gas turbine and generator are put together in an enclosure with fire and gas detection, alarm, and suppression systems. The enclosure is protected by with carbon dioxide suppression system and the fire alarm system is set on "auto", so the detection and alarm system is ready to activate at any sign of danger. The enclosure of the gas turbine-generator may be opened only to check the inside of the unit when the fire detection panel is on "inhibit" to prevent discharge of CO2 into the enclosure. The operator should be aware of asphyxiation if CO2 is discharged. Asphyxiation is when someone suffocates and is unable to breathe normally because of a depletion of oxygen.

Voltage of most systems is either 208V, 480V or 5kv to 15kv levels based upon the systems to which they are connected. **All electric voltages are dangerous and should only be operated by trained personnel.** Circuit breakers must be installed to electrically isolate a component of the Co-Gen for maintenance, or during overload or short circuiting.

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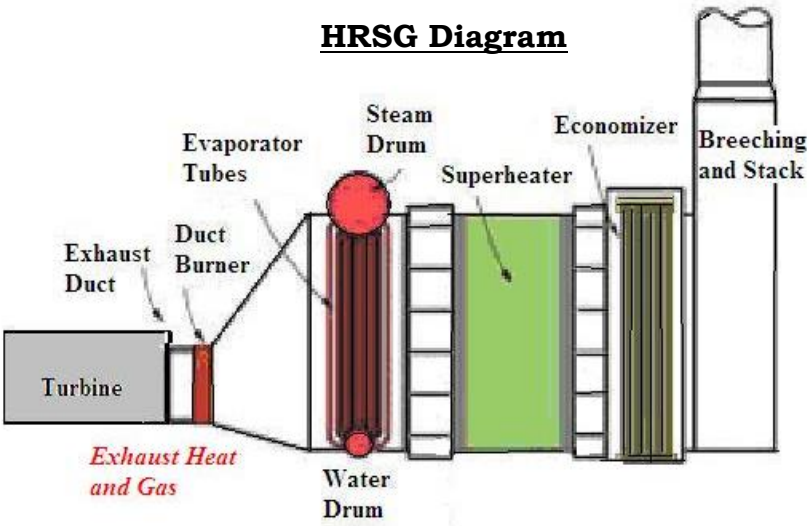
2.7) HEAT RECOVERY STEAM GENERATOR (HRSG)

Exhaust heat and gas recovered from the turbine is used to supply hot water, steam, space heating and even cooling. Often, the heat is used for a boiler, where hot water is heated up for heated water or steam. The HRSG is similar to a boiler and is located at the end of the exhaust duct of the turbine.

HRSG Diagram



Duct Burner
If the system is producing a large volume of exhaust heat, the exhaust itself may be used to heat up water. If there is not enough heat, a duct burner uses additional fuel from the gas train or other gaseous fuel for supplemental firing to provide additional thermal energy. A damper is usually found near the duct burner to regulate the flow of air, and direct the exhaust heat and gas to the HRSG.

Duct Burner Gas Train

The **water drum** is a basin of water on the bottom of the HRSG. There are tubes connecting the water and steam drum, and absorption of heat from the exhaust and duct burner produces steam when water reaches the steam drum. The water level should be monitored, and have chemical and blow down control. Mud, dissolved solids, and other particles from the water and steam drum may collect at the mud drum.

The **steam drum** collects steam as the water boils and evaporates it to the top of the HRSG. The steam from the boiler may be used for hot water, driving a steam turbine to produce more electricity, a steam-driven chiller for cooling, etc. The steam may be superheated into dry steam, where pressure and heat is applied to dry out wet steam, which has more energy.
The operations of the HRSG are performed under a boiler or steam operator's license because of high pressure steam.

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An **economizer** may be used to reduce energy consumption. It takes the heat at the end of the boiler that is too low to make steam out and uses it to heat up the incoming feed-water.

Heat Recovery Steam Generator

The **breeching and stack** is a channel, vertical pipe, chimney, or similar structure through which combustion product gases called flue gases are exhausted to the atmosphere. It may consist of pipes throughout a building system until it directs the flue gases to a proper place to be released. Flue gases are produced when natural gas or any other fuel is combusted in a HRSG, boiler, turbine, or engine.

The operator needs to walk the system periodically to detect leaks of flue gas in the breeching, which may cause CO poisoning.

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3. OPERATING PROCEDURES

The operators must be familiar with the entire Co-Gen and be fully trained on the equipment that The operators must be familiar with the entire Co-Gen and be fully trained on the equipment of which they are in charge of and of which they have obtained the appropriate certificate of fitness for. It is the responsibility of the owner to provide the proper training.

Each Co-Gen plant has its own Standard Operating Procedure (SOP) regarding startup, operation, maintenance, shutdown, detection systems, and purging. At least one copy of the operating and maintenance instructions for the Co-Gen systems, and approved plans should be available on the premises. The plant manager will train the Certificate of Fitness holder on how to specifically operate for the plant. The operating procedures must be on-site, with copies in the control room, and the Certificate of Fitness holder has to be knowledgeable regarding them and strictly follow the procedures.

3.1) STARTUP, OPERATION, AND SHUTDOWN

The following are sample startup, operation, and shutdown procedure that the Certificate of Fitness holder must know and for which the holder must be responsible for. These procedures are to ensure that components are working before starting up, operating normally, and slowly shutdown in a series of steps to prevent damages to machines. Improper procedures will incorrectly run the machines are likely to create a hazardous environment.
(*DISCLAIMER: Operating procedures are different for different Co-Gen plants. Follow the instructions of the plant manager for each specific plant.)

3.1.1) Sample Cooling System Procedure

Startup:

1. Ensure the cooling towers and make-up water system is operating
2. Close the electric breakers to allow electricity to power the cooling system.
3. Set the variable frequency drive (VFD), which is an adjustable-speed drive by varying frequency and voltage depending on the amount of cooling needed, on “Auto”.
4. Open heat exchanger valves for select heat exchanger to allow cooling water to circulate to that component.
5. Start pump and confirm water flow. Set pump to “Auto”.

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During normal operation, the pumps will be set in “auto”. The lead pump will regulate the amount of make-up water, but this may also be controlled by the operator in the control room. The temperature of the water will depend on how heated the Co-Gen becomes and how effectively the cooling tower is removing heat. During the operation, the alarm should be monitoring for pump discharge pressure, and supply temperature and notify the operator of cooling conditions.

Normal shut down:
When shutting down the cooling system, ensure that no Co-Gen equipment requires cooling. Then, terminate pump operation from variable frequency drive, and put the breakers back on.

3.1.2) Sample Gas Compressor Procedure

Startup:

1. Record the date and time in the record keeping documents.
2. Ensure that all parts are cleared and unblocked and show no signs of wear or leak.
3. Turn power panel on and ensure the gas compressor motor is ready.
4. Verify lube oil, main motor, unit alarm, unit shutdown, and recycle valve is on and ready.
5. Make sure all input and outputs are confirmed.
6. Test to make sure all permissive are met as per checklist and shutdowns are working.
7. Start the lube oil system. It may shutdown if pressure is incorrect or does not reach the right pressure within a specified amount of time.
8. Turn on gas compressor when ready. Operating hours will be logged.

Normal shut down:
Reduce the input and output of the gas amount and pressure. Slowly shutdown the recycle valve, then shut down the gas compressor unit.

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Gas Compressor 100 Startup Procedure

Task #	Task Description	Employee Initial
1	Verify compressor motor breaker and Lube Oil Pump breaker (located on MCC-A) in the 480V switchgear room are CLOSED and switches are ON.	
2	Verify Process Cooling Water supply and return valves (V-1017 PCWS & V-1018 PCWS) located on the control side south wall are OPEN.	
3	Perform a visual inspection of the enclosure and check the oil level gauges.	
4	Verify vent valves (C GV 003 & C GV 004) located on the off control side in the enclosure at the compressor end are CLOSED.	
5	Verify gas suction valve (V-1012 MPG) and gas discharge valve (V-1022 HPG) are OPEN, and discharge gas vent valve (XCV-1016) located above discharge valve (V-1022 HPG) is CLOSED.	
6	Verify control panel power is ON, and Main Motor and LO Pump switches are in AUTO.	
7	In control room, select the F6 (FUEL OVERVIEW), SF1 (COMP/HIGH PRESS GAS) screen for the gas compressor overview. Click on the GC-100 automatic operated gas supply valve (XCV-1005). When pop up window for valve controls appears, OPEN valve in MANUAL, then switch to AUTO.	
8	Click the GC-100 automatic operated gas discharge valve (XCV-1009). When pop up window for the valve controls appears, OPEN valve in MANUAL, then switch to AUTO.	
9	Click on GAS COMPRESSOR GC-100 box and press SYSTEM START.	
10	On Allen-Bradley control panel at compressor, press SCREEN MENU => OIL HEATER CONTROL SCREEN and check actual temp is above the low SP.	
11	PRESS SCREEN MENU => RECYCLE CONTROL SCREEN => tap the SP value box and enter pressure 10# higher than the PV, but not less than 100 psi, then press enter arrow. Ensure discharge control is in AUTO.	

Page 1

Sample Startup Procedure Checklist

3.1.3) Sample Gas Turbine-Generator Procedure

Startup:

1. Record the date and time in the record keeping documents.
2. Inspect gauges, air inlet system for obstructions, oil tank levels, lube oil filters, lube oil system for leaks, gas fuel system for leaks, and all pipes and hoses for wear or leaks.
3. Confirm all blocks and tags removed, and alarm checks are cleared.
4. Make sure the compressed air system, HRSG, generator, and cooling system are connected and in service.
5. Close the electric breaker and start the gas turbine-generator unit. Start the combustor. Slowly warm-up and increase fuel firing pressure. Monitor unit acceleration, temperature, and load. Operating hours will be logged.

Checklist:

- Verify support systems are functioning as per checklist
    - For alternating current (AC) Motor Control Center, the main source of electric energy:

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        - Verify: control panel on, transfer breaker on, lube oil vent on, lube package heat on, lube oil pump on, lube oil vapor extractors on, electrical package HVAC on, all turbine enclosure vent fans, air compressor on, fuel oil flow dividers off, generator space heater on
    - For direct current (DC) Motor Control Center, the backup source of electric energy:
        - Verify: battery charger on, control panel board on, emergency lube oil pump on
- Verify Fire Protection and Detection System
- Mechanical Checks:
    - Verify overspeed trip switch is in function
    - Verify lube oil reservoir level and pressure, and lube oil filter pressure, and lube oil system bearing pressure, as indicated by pressure gauge
    - Verify ambient temperature
- In the starting package:
    - Inspect for oil leaks
    - Verify turning gear of the turbine is operating and rotating at a proper speed
- At the generator:
    - Inspect Lube oil, fuel gas, and fuel oil piping for leakage
    - Verify generator parts are on, such as the exciter.
- Turbine Enclosure:
    - Inspect enclosure for irregular conditions
    - Ensure access doors are closed

Normal shut down:
Stop the system and open the circuit breaker. Cool down the system slowly and stop introducing fuel and combustion ceases. The unit slows down and stops logging operating time. A post-lubrication may be performed.

3.1.4) Sample Heat Recovery Steam Generator Procedure

Startup:

1. Ensure that all parts are cleared and unblocked and show no signs of wear or leakage.
2. Fill the steam and mud drum, and open all vents and drain lines. Fill with water at an increasing rate until it reaches desired water level.
3. Start the gas turbine at its minimal rate, and slowly increase.
4. Duct burner can be started accordingly.

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5. Make-up water, chemical feed and sampling system, mud drum condensate system, blow-down control and lube oil system is working and monitoring the system.
6. The heated steam and water may be used for heating or boiling water elements in the building.
7. Optional: Steam turbine generator may be turned on and ready for steam from the HRSG to produce electricity.

Normal shut down:
Press the shutdown button and slowly reduce load on the HRSG and produce less steam. Shut off duct burner and reduce the load on the gas turbine. A post purge and clean out of the HRSG may be performed.

3.1.5) Sample Gas Detection System Procedure

Startup and Operation:

1. Confirm power supply to chargers and panels.
2. Calibrate detectors per manufacturer's recommendation and FDNY Letter of Approval.
3. Observe the gas detector panel is powered and operating.
4. Confirm no system or detector errors are present.

The gas detection system is to remain active and powered, and support the entire plant, at all times. The system must be checked and the detectors calibrated per manufacturer's recommendations. It is connected to the fire alarm panel, emergency power, and battery backup system. The fire alarm panel may connect to output devices such as gas valves, fan, dampers, and inlet air and shut them down in case of a serious alarm. Visual inspections must be conducted at least once per shift.

If there are supervisory or trouble signals, observe the gas detection panel and find out which detectors are in alarm. Acknowledge the alarm and investigate the cause of the alarm and try to clear it. If an irregular condition persists, log it in the log book and bring it to the plant manager's attention. Confirm appropriate fans are running, take remedial action, and evacuate area if levels of natural gas or CO continue to rise. Once levels of gas have returned to normal, observe the detectors are working, and reset the gas detection panel, fire alarm system, and gas valve (if gas valve shutdown has occurred).

3.2) PURGING

3.2.1) Natural Gas Piping Operations and Purging

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It is dangerous to introduce natural gas into the piping systems and components when the system is filled with oxygen from the air. An explosion may result when a certain concentration of natural gas and oxygen mixes. During initial start up and taking the system out of service, natural gas piping is purged with inert gas or nitrogen throughout the system to displace all the oxygen in the pipes.

During startup, nitrogen is fed into one end of the system and the concentration coming out of the other end must be tested to ensure that little or no oxygen remains in the system (less than about 8% oxygen). Then, the gas valves may be opened to introduce natural gas into the system, and the concentration of methane is tested, for about a concentration of 98%, and allow normal operation of the Co-Gen.

When taking the system out of service, the opposite procedure occurs and nitrogen is introduced into the pipes to remove natural gas. Whenever there is a filter, a purge may be performed prior to removing the filter to remove natural gas odor. For example, filters in the gas compressors may be purged before the filters are changed to prevent strong natural gas odor from being released to the atmosphere or affecting people in surrounding area.

The gas purge in and purge out requirements are outlined in NFPA 56, and each Co-Gen plant has a NFPA 56 required purge in/purge out procedure specific to each site. A licensed engineer writes the procedure and the Certificate of Fitness holder is responsible for knowing the procedure.

3.2.2) Combustible Flue Gas Operations and Purging

The vent valves, bypass, and stacks are open during startup and closed before normal operation. During shutdown, natural gas and unburned fuel in the system are safely purged and vented out before the system completely shuts down and is exposed to oxygen in the air again.

This purge of components for the boiler or the HRSG, may be performed during operation or after shutdown to purge out flue gas or remove unburned fuel from gas piping. After the fuel gas valve shuts, the ventilation fans are run, the flue gas is purged into a furnace or runs through a stack. Usually, the purge of combustible flue gas is for a duration of 6 times, or at least 5 minutes.

The combustible and boiler system hazard codes are outlined in NFPA 85, and each Co-Gen plant has a NFPA 85 required combustible flue gas operation and purging procedure specific to each site. A licensed

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engineer writes the procedure and the Certificate of Fitness holder is responsible for knowing the procedure.

4. MONITORING SYSTEM HEALTH

The Certificate of Fitness holder should periodically conduct a **visual inspection** of the whole Co-Gen system. Such inspections should be conducted as frequently as needed to ensure safe operation. **Premises should be inspected daily for signs of equipment malfunction and gas leaks. There shall be a 24-hour monitoring system (automatic and manual systems). There must be at least 1 operator on site at all times throughout the 24-hour day. All of the holders are required to perform functions which involve monitoring and maintaining the Co-Gen systems health. Diagrams of the Co-Gen and signs must be posted at conspicuous locations and control room, and indicate hazards, safety protection systems and egress.**

All equipment that is connected for use but not in use, including the outdoor gas service line shut-off valve (curb valve or gas supply hatch), should be inspected at least once every day. The Certificate of Fitness holder should ensure that all gas piping, appliances and equipment are in a safe condition and are in proper working order. They should be maintained and operated safely and in compliance with the prescribed installation requirements.

The manufacturer or qualified service personnel should be notified of any irregular situations and be consulted promptly when additional information is needed on site. **The Certificate of Fitness holder MUST NOT attempt to perform any repairs to the systems that they are not qualified to maintain or without plant manager's approval.** The equipment must be serviced and/or repaired by a representative of the manufacturer, an authorized professional by the plant manager or by governing entities, or manufacturer-trained maintenance crew in accordance with the manufacturer's instructions.

Regular preventive maintenance is highly recommended. Regular preventive maintenance reduces the need for system shutdown, which plants try to minimize because it stops producing energy and is costly to startup and shutdown again. When performing maintenance, the enclosure doors should not only be opened after disabling the CO2 system or properly shutting down the unit. Hot surfaces, high voltage, and rotating machinery can cause serious injuries or death. The maintenance procedure of required preventive maintenance, frequency of

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completion, and the responsible party (plant maintenance staff or vendor) should be maintained within the plant.

At least one copy of the operating and maintenance instructions for the Co-Gen systems, and approved plans should be available on the premises. A copy of the recommended preventive maintenance program, recommended by the manufacturer, shall be available on the premises. The recommended preventive maintenance schedules document required preventive maintenance, frequency of completion, and the responsible party (plant maintenance crew or vendor) should be kept in the plant. A maintenance summary sheet shall document the actual maintenance work performed, who performed the work, and other relevant information.

4.1) MANUFACTURER SERVICE CONTRACT AND MANUAL

Manufacturer service contract and manual must have:

- Regular service and emergency contact information, including names and phone numbers of the service providers.

The Certificate of Fitness holder should establish and maintain an efficient method of contact in case of emergency, and should keep a direct dialogue with the authorized service personnel. All the information should be current and accurate.

The manufacturer of the Co-gen equipment should establish a recommended schedule of preventive maintenance program for each model. The preventive maintenance program should include the manufacturer recommended service **intervals**, **and specific responsibilities for the manufacturer** and for the **end-user (Certificate of Fitness holder)**.

The service contract for major system equipment must be valid for throughout the use and service of the equipment.

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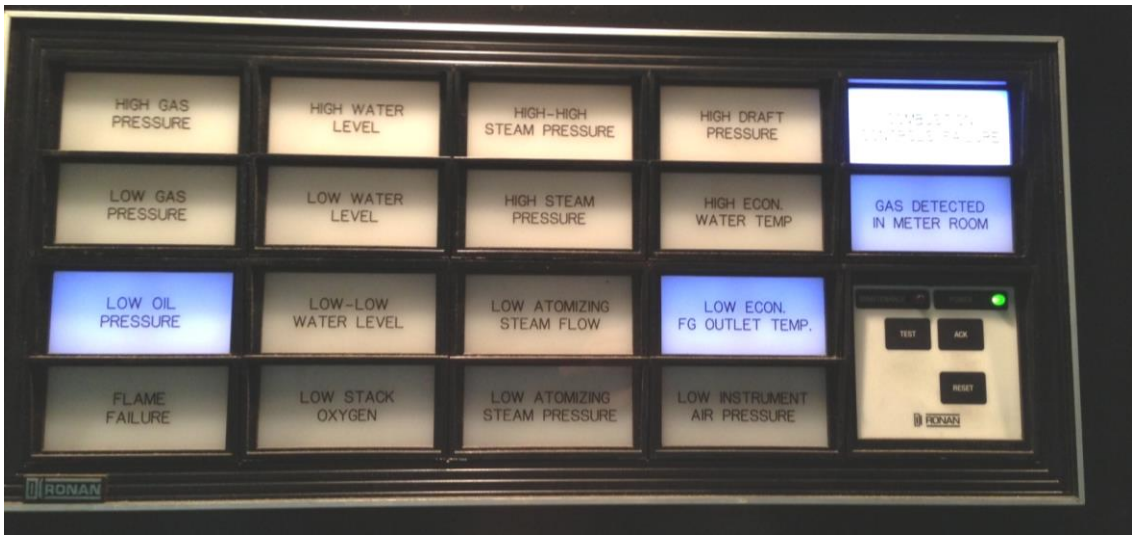
4.2) OPERATOR SUPERVISION



Example of Parameters Monitored Under the Operator's Supervision

Operator supervision and maintenance of the system equipment and parts are required and should be performed at established intervals. The recommended intervals vary for different environmental and operating conditions, and depend on hours of operation. The local environment and location, operating conditions and practices, equipment installed, and the availability of skilled technicians must be carefully considered in establishing a maintenance plan. Preventive maintenance at specific intervals minimizes corrective maintenance or hazardous conditions. The operator must read the operation, maintenance, startup and system manuals and become familiar with the control systems.

Checks are performed during regular intervals throughout the day, and readings such as temperatures and pressures of system components must be noted and recorded during rounds in a log sheet. The daily activities must be summarized in a plant log book, their daily status of the Co-Gen noted and monitored. The FDNY recommends that the log book record the hours of operation of the equipment to account for the routine maintenance and repairs that have to be performed. More detailed inspections and maintenances occur monthly, semi-annually, or annually, those inspections involve checking protection systems, ensuring optimum performance, cleanliness, and may require disassembly of subsystems or system shut-down.

OPERATORS MUST PERIODICALLY MONITOR THE C0-GEN AND PERFORM OPERATIONAL AND MAINTAINENCE CHECKS FOR THE FOLLOWING, BUT ARE NOT LIMITED TO:

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(*DISCLAIMER: Different Co-Gen systems may have different maintenance schedules to ensure safe and proper operation. Follow the instructions of the plant manager for each specific plant.)

4.2.1) General Checks

- Original installation of the plant cannot be modified until approved by proper agencies, such as the Department of Buildings and the FDNY.
- Ensure that areas with ventilation and exhaust fan be continuously ventilated, the area around machine has proper clearance, and that the ventilation of gas from a valve is at a safe level.
- Ensure that the area, doors, pipes, enclosures, and machineries are secured and have correct and clear labels and warning signs, such as indicating high pressure gas, shut-off valves, or emergency protocol and egress.
- Ensure that materials with flammable, incompatible, or hazardous nature are not near each other or near operating machinery, such as O2 in pipes carrying natural gas or smoking nearby.
- Ensure that alarms, detectors, system flow controls, warning and shutdown devices are in working order and are calibrated according to manufacturer's instructions, and maintained in compliance with safety regulations.
- Inspect pipe, valves, pumps, and ducts for integrity, leaks, proper function, or insulation.
- Check for possible seal failure; for certain failures, indicators may be gas leaks, hot spots, or casing discoloration.
- Be alert for any unusual operating conditions, such as excessive vibration, smell of gas, overheating, or other signs of system wear or malfunction.
- Defective electronic components, lighting, and control system must be replaced, properly repaired, or switched to backup system; hazards may be presented by exposed electrical wires, etc.
- Check for corrosion, erosion, or deposits in piping.
- Pressure, temperature, water level, oil level, flow rate reading of components throughout Co-Gen need to be recorded and irregular readings must be investigated.
- Ensure that lubricating oil system is functional, with proper circulation of oil, oil makeup system, oil quality and filters, lube oil level, and cooling. Lube oil must be stored properly away from incompatible materials, not be stored for too long, and be properly stored away from electrical rooms.
- Cooling water level and quality needs to be controlled. Water must not freeze up during cold-month operations.

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- Floors must be cleaned from spills and not slippery or obstructed.

4.2.2) Gas Compressor Checks:

- Filter and lubrication oil is clean and replaced periodically.
- Coalescing elements in the inlet suction scrubber and the discharge separator are clean and changed periodically.
- Proper inlet and outlet pressures in parts of a gas compressor.
- Irregularly strong gas smell or excessive vibration of machinery must be inspected.

Irregular conditions:

- If gas valves fail-open, there is a potential for fire in the Co-Gen or nearby buildings. Gas and fire detection system will alarm.
- If the cooling system tube fails, natural gas can flow into the cooling water system and go to the boiler room and cause a potential explosion. Vent the gas to a safe location.
- If the lube oil cooler tube fails, lube oil can flow into cooling water and cause potential pressure increase. Verify the valves and contact the manufacturer if a compressor shutdown is needed.
- If there is a leak in a pipe or fitting, this can result in flammable vapor accumulation or fire. Enclosure must be ventilated and gas detector can cause an alarm and a trip.
- High level of water in supplied natural gas to be compressed could increase wear because of water reducing lubrication. Excessive water also reduces combustion efficiency when compressed gas is supplied to the turbine. Ensure the gas filter and suction scrubber remove water and excessive moisture. This can all cause an alarm and a trip.
- Make sure that the flow is consistent and proper. Loss of cooling can result in excessive vibration or overheating. Insufficient oil flow can result in damage to bearings or high oil temperature. This can all cause an alarm and a trip.

4.2.3) Turbine or Engine, and Generator Unit Checks:

- Air systems shall be obstructed and uncontaminated.
- Filter needs to be replaced as needed.
- Monitor and record fuel pressure and readings.
- Inspect igniter torch or combustor for cracks, overheating, or wear.
- The gas turbine-generator enclosure is secured, with fire and gas protection system working properly.
- Control panel working and is set on auto. Set it on “inhibit” only when opening the gas turbine-generator enclosure for checks, and set it right back to “auto” to turn the fire detection and CO2 suppression system back on.
- Verify load and amount of electricity and heat produced.

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- Circuit breakers are in proper working order, and cut off electricity if overloading or short circuiting occurs, or electrically isolate a system component for maintenance.
- Integrity of the exhaust duct must be maintained. It discharges hot exhaust gases, and appropriate sign and insulation must be installed to prevent hot temperature burns and carbon monoxide poisoning.

Irregular conditions:

- Emergency shutdown must be activated in case of emergency, such as severe gas leak or loss of turbine speed control. Unload generator and engine shuts down with no cool down cycle.
- If there is gas detection or overpressure reading in turbine or boiler, there may be a potential for fire. Gas and fire detection system will alarm, exhaust ventilate will increase to the maximum, and gas compressor inlet and outlet valves will shut down.
- If there is a discharge of CO2 while someone is inside the turbine enclosure, there may be potential asphyxiation. Deactivate the CO2 system, and lock the discharge valve between the CO2 supply and the enclosure.
- Ensure that the flow is consistent. Loss of cooling can result in excessive vibration or overheating. Insufficient oil flow can result in damage to bearings or high oil temperature. This can all cause an alarm and a trip.

4.2.4) Heat Recovery Steam Generator (HRSG) Checks:

- Monitor the feed-water system, such as water chemistry and quality, total dissolved solids, and water level.
- Duct burner operating at correct parameters and temperature, gas-fuel system is working properly and clean.
- Note the:
    - Amount of total dissolved solids in concentrations;
    - Water drum and steam drum water level;
    - Control lines and filters;
    - Excessive soot, deposits, or signs of corrosion.
- Inspect breeching, exhaust ducts, or stacks for damage, distortion, or CO level.
- Check for exhaust temperature and pressure.
- Perform tube care of the tubes connecting the drums, including tensile tests and cleaning. Check for corrosion or erosion.
- Clear and accurate reading of the gauge glass.
- Ensure that the mud drum, which collects the mud, dissolved solid, and other particles in the water or steam drum, is monitored and cleaned.

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4.2.5) Fire and Gas Protection System Checks:

- Confirm power supply to detectors and panels. Panels shall have 24-hour supply battery backup.
- Confirm that the fire and gas detectors are active and producing accurate readings and show no signs of faults.
- Investigate alarm, supervisory, or trouble signal on the fire alarm panel and the gas detection panel.

5. FIRE SAFETY REGULATIONS

The fire safety system is implemented and maintained based on prescribed procedure from licensed engineers and the Fire Department. The Letter of Approval from the FDNY to each specific Co-Gen premise details the necessary safety measures and design requirements after papers and plans are reviewed, and process hazard studies are conducted.

***FIRE PREVENTION AND PROTECTION SYSTEMS ARE REQURED TO BE INSTALLED AND MAINTAINED IN THE CO-GEN PLANT.** The Fire Department must be notified when any part of the fire protection system is shut down or modified. This will allow the Fire Department to modify its fire-fighting strategies for the plant in case of an emergency, and to reevaluate the fire protection system. Also, in case of any malfunctions, the Certificate of Fitness holder must notify the management of the plant and the management must make arrangements to have the Fire Protection System repaired or replaced. A violation will be issued to the Certificate of Fitness holder when the Fire Department rules and regulations are not followed at the plant. In serious cases, the Certificate of Fitness may be revoked and summonses may be served.

The **fire alarm panel** monitors the entire Co-Gen plant. The panel receives information from environmental sensors designed to detect changes associated with fire, monitors their operational integrity and provides for automatic control of equipment, and transmission of information necessary to prepare the facility for fire based on a predetermined sequence. Any supervisory signal will be sent to the FDNY approved central station and be noted. Any serious alarm signal will be

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transmitted to the central station for FDNY's operational response to the premises. The operator must immediately call 911 in case of an emergency.

5.1) FIRE DETECTION SYSTEM

A fire detection and alarm system signals when there are signs of an imminent fire. Early detection of a fire condition allows the plant to initiate proper safety procedures. Any alarm must send a signal to the fire alarm panel and the control room for the Certificate of Fitness holder to take action.

5.1.1) Fire Detectors

There are several types of fire detectors are found throughout the Co-Gen plant.

A **heat detector** detects irregularly high temperature or rate of temperature rise. Fixed temperature heat detectors activate the alarm when detector components melt at a preset temperature level. This usually requires replacement after they have sounded an alarm. Rate-of-Rise heat detectors sense temperature increase per minute, regardless of the starting temperature. This type of heat detector can operate at a lower temperature fire condition than would be possible if the threshold were fixed. The rate-of-rise detector does not have to be replaced after it has activated the fire alarm. Combination detectors may use both types of heat detectors.

Heat Detector

A **smoke detector** is a device that detects smoke, which is an indicator of imminent fire, in a Co-Gen plant. Smoke is a collection of airborne solids, liquid particles, and gases which occur when a material burns, such as during a fire. Smoke detectors detect fire more rapidly than heat detectors by sensing smoke particles. The smoke particles may or may not be visible to the human eye.

Flame detectors may be found in some Co-Gen plants. They detect a flame,

Flame Detectors

which is the visible, gaseous part of a fire caused by a highly exothermic reaction, such as during burning. There are several types of flame detectors. The most common is the optical flame detector, which uses optical sensors to detect flames. Infrared and ultraviolet detectors are each a type of optical sensor.

Infrared or ultraviolet flame detectors are installed throughout a Co-Gen system, in the gas turbine-generator enclosure and gas compressor room. Hot gases emit a specific spectral pattern in the infrared region, which can be sensed with a thermal imaging camera. False alarms can be caused by other hot surfaces and background thermal radiation in the area as well as blinding from water and solar energy. A flash from a camera can set off the flame detectors, and shut-down the system; therefore, in Co-Gens with flame detectors, cameras with flash are prohibited from the turbine room.

5.2) GAS DETECTION SYSTEM

An automatic gas detection and alarm system signals when there are signs of hazardous concentrations of gas. Early detection of a gas leaks or hazardous gas concentrations allow the plant to initiate proper safety procedures. Any alarm must send a signal to the gas detection panel and the control room for the Certificate of Fitness holder to take action.

5.2.1) Gas Detectors

A gas detector is a device which detects the presence of various gases within an area, usually as part of a safety system. This type of equipment is used to detect a gas leak and interface with a control system so a process can be automatically shut down, the plant personnel can be notified and the required ventilation system can operate to exhaust the affected areas. Gas detectors in the cogeneration plant are installed to detect combustible, flammable and toxic gases, and oxygen depletion.

Gas Detectors

Carbon monoxide detectors are found where leaks can occur such as in the turbine exhaust, HRSG and boiler areas of the plant.

Natural gas detectors are found in the gas meter and main valve rooms, gas compressor room, gas turbine, HRSG area and other areas where

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natural gas is supplied or vented, and a leak is possible such as within the annular space of double wall gas piping.

Oxygen depletion detectors are generally of the portable handheld type and are used by personnel responding to alarms relating to the CO2 extinguishing system discharge in equipment such as a gas turbine or gas compressor enclosure.

All gas detectors must be calibrated on a schedule in accordance with the manufacturer's recommendations and the FDNY Letter of Approval. The atmosphere in which a gas detector is being used can have an affect on the sensors. Sensors may suffer degraded performance normally over time and also if exposed to certain substances that affect the sensing elements. As part of the calibration process, the manufacturer or an authorized vendor certified to maintain the gas detection systems will test the gas detectors by looking at the gas reading relative to the atmosphere, and perform a bump test, which exposes the detector to known concentration test gas to check the accuracy of the reading.

The gas detection system has alarm, supervisory, and trouble notification within the plant:

Alarm conditions send an alarm signal to the control room. It activates the fire alarm system and gas detector system horn and strobes, indicates dangerous levels of gas in the Co-Gen, and is programmed to trip the system and notify the central station and FDNY.

Gas Detection Panel

Supervisory conditions send a supervisory **(warning)** signal to the control room and the central station. It indicates warning conditions such as irregular levels of gas that must be inspected.

Trouble Conditions send a trouble signal to the control panel for the operator to investigate a device or wiring fault or defect, so that an appropriate repair can be provided.

5.2.2) System Description

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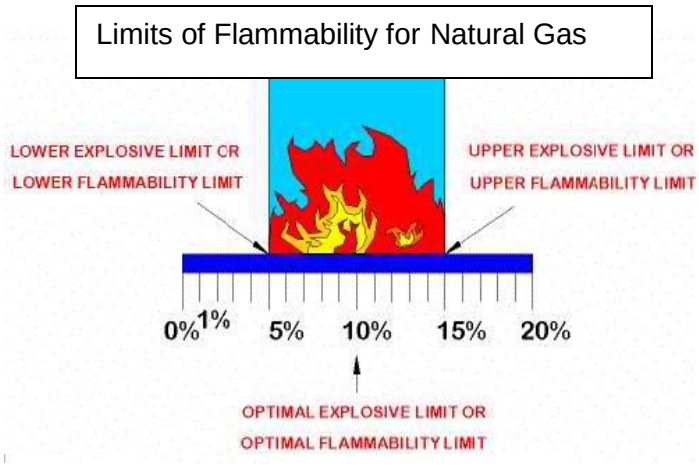
The gas detection system shall protect all areas of the Co-Gen plant where gas leaks are possible and are to be continually powered and functional. Gas detectors send and receive signals from an approved **gas detector panel**. The control units vary by manufacturer but are likely to include a front panel meter or LCD to indicate the gas concentration at each sensor. They will also normally have internal relays to control functions such as alarm, fault and shutdown and to communicate alarms to the building's main fire alarm panel and to the FDNY. Gas detector for natural gas, detect gas concentrations as a percent of the natural gas concentration lower explosive limits (LEL). The LEL is the concentration of natural gas that can cause an explosion when exposed to an ignition source. For natural gas, the range of methane concentration in the air required to allow an explosion is around 5%-15%. Gas detectors are set to respond to a percent concentration of gas (relative to the 5%-15% LEL concentration) so the detection and alarm conditions occur before the actual LEL concentration is reached. This allows personnel time for proper response. As gas levels are detected, ventilation systems in the detection area will start to exhaust the natural gas and send a supervisory signal to the FDNY. This usually occurs when the natural gas concentration in the air is 15% of the 5% explosive LEL concentration so the actual concentration is still low. If gas concentrations continue to rise to 25% of the LEL the plant will go into alarm. **LEL alarms** sound an alarm throughout the plant and then trip the generator and close the main gas valves depending on the concentration of natural gas detected. LEL alarms also send alarm signals to the FDNY.



Carbon Monoxide (CO) detectors are also connected to the gas detection panel and are set to detect concentrations of CO parts per million (ppm). CO levels are hazardous for exposure over long periods. CO detectors may be set to alarm in the range of 50 to 100 ppm and will sound an alarm throughout the plant and send a supervisory signal to the FDNY.

Oxygen depletion detectors are used to detect oxygen depletion caused by the discharge of CO2 in the turbine or gas compressor. Generally the CO2 fire suppression system cylinders are monitored to ensure that leaks have not occurred. In the event of a leak, the turbine alarm system

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will send a supervisory signal to the buildings fire alarm system and to the FDNY.

Exhaust fans and other mechanical ventilation devices are started to ventilate the area when dangerous amounts of gas are detected.

5.2.3) Turbine and Gas Compressor Protection Systems
The gas turbine and the gas compressor room may each have a separate detection and alarm system in addition to the site-wide detection and alarm system around the Co-Gen. All detection and alarm systems are connected to the fire alarm panel. Fire and gas detectors are installed in these areas, and a CO2 suppression system discharges CO2 if it detects a gas leak or an imminent fire.

The site-wide fire alarm and gas detection safety systems go off when the turbine and gas compressor gives off alarm signals. If both the alarm system of the entire plant and the gas turbine-generator unit is activated, and the operator should stay clear of the gas turbine area until the alarms are investigated with caution by authorized personnel or the FDNY.

5.2.4) Gas Leaks
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.

The plant manager should have instructions posted and readily available on how to respond in case of natural gas leaks. Contact the manufacturer for specific procedures for your equipment.

Sample of Procedures in Case of Natural Gas Leak:
1. Immediately cease operation of affected system components 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.

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C. Use a gas leak detector to 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 conducting complete remediation of the condition causing the natural gas leak.

Automatic gas detectors are installed around the plant. The air around pipes is sniffed for pinhole leaks. If gas is detected, gas detectors will send a signal to the control panel or control room, or automatically shut down the Co-Gen.

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5.3) FIRE EXTINGUISHING DEVICES

Fire extinguishing devices are a fire protection device used to extinguish or control small or imminent fires. It is not intended for use on an out-of-control fire, such as one which has reached the ceiling, endangers the user (i.e., no escape route, smoke, explosion hazard, etc.), or otherwise requires the expertise of the FDNY.

5.3.1) Carbon Dioxide (CO2) Fire Suppression System

CO2 fire suppression system cylinders

Gas turbine-generators enclosures and gas compressor rooms usually have a suppression system (CO2, water-mist) installed. A suppression system plays an important role if a fire or gas is detected. If the fire or gas detection system is activated, the unit shuts down and the valves shut-close. **CO2 fire suppression system cylinders** containing carbon dioxide are lined up around the enclosure and the gas compression room, and are triggered to activate and put out a potential fire if the fire alarm panel is activated. The CO2 level in the cylinders must be monitored. A low pressure supervisory signal from the CO2 fire suppression system cylinder or an oxygen depletion detector lets the operator know that CO2 needs to be refilled. CO2 fire suppression system cylinders may need to be refilled because they are discharging, because of activation of the fire or gas detection system, or that the CO2 fire suppression system cylinders are leaking. A hand held portable leak detector may then be used to investigate for a potential gas leak, or that the cylinders lost their integrity and needs to be repaired or replaced. An operator must be aware of an area with large amounts of CO2 discharge, which may cause asphyxiation.

5.3.3) 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.

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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.

Instructions on proper Fire Extinguisher use

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 occur when flammable liquids, gases or grease 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 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 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.

Classes of Fire

Symbols may also be painted on the extinguisher. The symbols indicate what type or class of fires the extinguisher may be used upon.

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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.

5.4) EMERGENCY PROTOCOL

Every premises where Co-Gen systems are installed and operated must have a fire safety plan detailing procedures that must be followed during an emergency, fire, natural gas leak or other urgent situation. The plan should highlight methods for shutdown of the Co-Gen as well as fast and safe evacuation of the premises. **The Certificate of Fitness holder must know and understand his or her responsibilities as they are outlined in the premises' fire safety and evacuation plan**.

The Certificate of Fitness holder must know the locations and how to operate all fire extinguishing devices and control devices installed at the facility, such as standpipes and sprinklers. He or she must also know the locations of each fire alarm station on the premises, if applicable, and how to operate them. **Diagrams of the Co-Gen and signs must be posted at conspicuous locations and control room, and indicate hazards, safety protection systems and egress.** Keys to the gas meter room, gas compressor room, or other securely locked rooms shall be readily available in the control room and shall take less than one minute to retrieve and open in case of an emergency. **Any revised plan for Co-Gen and related equipment must be submitted to FDNY, including fire protection, emergency action, and fire safety plans.**

The Fire Department strongly recommends that Certificate of Fitness holders of the Co-Gen systems be trained to alert the plant manager and the Fire Department immediately at any sign of danger.

If possible, training sessions should be conducted periodically and all personnel and occupants should be knowledgeable of the safety procedures that must be followed during an emergency.

In all cases, the Fire Department must be contacted directly by phone in case of an emergency or serious safety condition, by immediately dialing 911. It is suggested to have the Fire Department Borough Communication Office phone numbers posted near the

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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

Ear protection, hard hats, eye wash stands, showers, or other protection and emergency treatment stations should be readily available around the system. Warden phones should be available by the gas turbine-generator, control room, and other locations throughout the Co-Gen plant. They shall be used for direct communication with building's fire command station.

5.4.1) Emergency Stop (E-Stop) System

An E-Stop system is a system of normally closed switches that are wired in series. Emergency stop system is provided to manually shut down the plant or a section of the plant in emergency situations, and is located throughout the Co-Gen. The emergency stop system by-passes the normal shut-down sequence. **E - Stop shutdown system can be damaging to equipment and should only be done when all other measures to shutdown equipment have been exhausted.** Equipment can be damaged upon sudden stoppage of equipment under an E-Stop function. Operators need to be fully trained by equipment vendors on the shutdown procedures for each specific piece of equipment.

Emergency Stop System

When the operation of an emergency stop push button in the control room or other locations is initiated, an immediate shutdown of the Co-Gen system is brought about by passing the standard shut-down procedures. All safety procedures in connection with normal start-up and shut-down should be followed, which includes closing the main gas valve. Electrical hazards should be considered when conducting any maintenance.

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5.4.2) Egress

The number of emergency exits is determined by the FDNY during approval of the system and is shown on the fire safety plan, and the exits shall be clearly indicated for evacuation. The entry area should be unobstructed outside the Co-Gen for FDNY entry in case of a fire or emergency. There shall be a curb valve or gas supply hatch, which is the outdoor gas service line shut-off valve. This is for utility company to cut off gas supply from outside the building to minimize further endangerment of the premise or surrounding facilities. The FDNY can latch close the gas supply inside the Co-Gen from the fire alarm panel using the automatic shut-off valves.

Curb Valve

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6. RECORD KEEPING

At least **1** Certificate of Fitness holder must be on duty in a Co-Gen plant at all times. The Certificate of Fitness holder must be familiar with the entire plant and must conduct regular inspections of the entire Co-Gen system. The Certificate of Fitness holder must sign and date all the records.

Record keeping documents keep track of Co-Gen plant conditions and related activities, and help monitor operational or safety related parameters. A **round sheet** shall be kept on the premise to document detailed readings of system parameters, such as temperature, pressure, water level, input and output, of each component during each shift. A **log book** shall be kept on the premises to document the overall operation, condition, and activities in the Co-Gen plant systems during each shift. A **maintenance summary sheet** shall document the actual maintenance work performed, who performed the work, and other relevant information.

The original records, permits, and Certificates of Fitness must be available on the premise, and made available to Fire Department representatives upon request.

6.1) SHIFT CHANGE OVER

Effective communication of plant conditions from one shift to the next is extremely important to the safe and reliable operation of the plant. At the beginning of the day, the plant manager will review the log book to check for any irregular plant conditions or issues he or she needs to discuss with plant operators. It is good practice for an incoming operator to communicate with the operator going off shift, and read the rounds sheet and log book to update themselves on what has happened in the plant. This should be done at the start of each shift.

6.2) SAMPLE ROUND SHEET

The operator should go out to the field and visually inspect and record readings, rather than just obtain readings from the control room monitor. This ensures that the plant has manual as well as automatic monitoring of the Co-Gen. An oil spill, small gas leak, or wet floor may not send a signal to the control room, but the operator on watch should notice possible conditions such as these while they are walking around on duty.

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A round sheet, at minimum, has the following information:

- The operator(s) on watch
- Time on/off watch, and intervals of time the measurements are taken
- Kilowatt hours of electricity produced
- All relevant plant system parameters such as pressure, temperature, flows, etc.
- Natural gas, steam, and lube oil usage
- Ambient temperature
- Water or oil level and quality or chemistry testing (if performed on shift)
- Other operational or safety related parameter
- Irregular reading or notes at variance with expected readings

CTG-100 Readings	Range	0000	0200	0400	0600
Engine Fired Hours	list				
Engine Starts	list				
Turbine Speed NGP (14,951 rpm setpoint)	percentage				
Gas/Liquid (Selected - Active)	list				
Gas Fuel Supply Press.	205-300 psi				
Gas Fuel Supply Flow (lb/hr)	2300-3000 lb/hr				
Liq. Fuel Boost Pump (100) Discharge Press.	25-35 psi				
Liquid Fuel Flow (lb/min)	45-55 lb/min				
Air Inlet Δ Press.	4.5-7 psi				
Pcd (Air Compressor Disch.)	90-200 psi				
Air Intake Temp. (T1)	ambient				
Combustion Temp. Avg. (T5)	(1250 F)				
Enclosure Temp.	< 120 F				
L.O. Header Temp.	130-150 F				
L.O. Header Press.	55 psi nominal				
Lube Oil Tank Temp.	145-155 F				
L.O. Tank Level	verify/maintain				
L.O. Filter Δ Press.	< 30 psi				
Generator Actual Power	< 5500 kW				
Generator Voltage	(4160 V)				
Generator Amperage	< 919 amps				
Generator Frequency	(60 Hz)				
GC-100 Readings	**Range**	**0000**	**0200**	**0400**	**0600**
GC Lube Oil Level	verify/maintain				
Suction Press.	(60 psi)				
Discharge Press.	205-300 psi				
Discharge Strainer Δ Press.	< 5 psi				
GC Gas Discharge Temp.	180-195 F				

REMARKS / SIGNATURES	
2300-0700	
1st OP:	
ENGR:	

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Electrical Distribution (Pg. 12)
Meters - Rotation End

Sample Round Sheet

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6.3) SAMPLE LOG BOOK

A log must record the routine maintenance and the repairs performed. The FDNY recommends that the log book record the hours of operation of the equipment to account for the routine maintenance and repairs that must be performed. Any daily inspections performed to the system equipment, including any action taken must be documented by the Certificate of Fitness holder, and the plant manager will review it daily.

The log book should be bounded with pages labeled, with each entry organized by chronological date.

A log book, at minimum, has the following information:

- The operator(s) on watch
- Time on/off watch
- Hours of operation and kilowatt hours of electricity produced
- Starting plant condition from beginning of watch, and ending plant condition when leaving shift.
- Emergency conditions
- Any equipment out of service
- Equipment rotation, alignment, or any irregular changes in operating conditions
- Required preventive or corrective maintenance performed during shift
- Alarm and safety conditions
- Any injuries or other safety related parameter
- Any visitors to the plant, such as vendors or agency officials, should be logged

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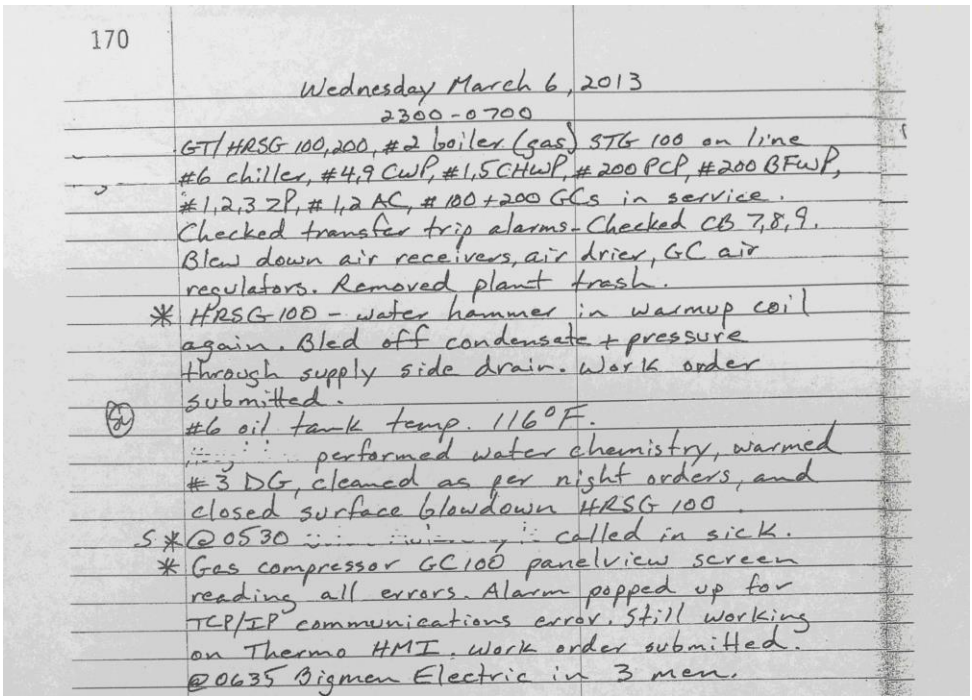

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Wednesday March 6, 2013
2300-0700
GT/HRSG 100,200, #2 boiler (gas) STG 100 on line
#6 chiller, #4,9 CWP, #1,5 CHWP, #200 PCP, #200 BFWP,
#1,2,3 ZP, #1,2 AC, #100+200 GCs in service.
Checked transfer trip alarms - Checked CB 7,8,9.
Blew down air receivers, air drier, GC air
regulators. Removed plant trash.
* HRSG 100 - water hammer in warmup coil
again. Bled off condensate + pressure
through supply side drain. Work order
submitted.
#6 oil tank temp. 116°F.
performed water chemistry, warmed
#3 DG, cleaned as per night orders, and
closed surface blowdown HRSG 100.
S * @ 0530 called in sick.
* Gas compressor GC100 panelview screen
reading all errors. Alarm popped up for
TCP/IP communications error. Still working
on Thermo HMI. Work order submitted.
@ 0635 Bigmen Electric in 3 men.

Sample Log Book

7. FDNY INSPECTIONS

A Certificate of Fitness holder should make regular inspections of the Co-Gen system. **Premises should be inspected daily for signs of equipment malfunction and gas leaks. There shall be a 24-hour monitoring system (automatic and manual systems). There must be at least 1 operator on site at all times throughout the 24-hour day. All of the holders are required to perform functions which involve monitoring the Co-Gen systems health.**

The original records, permits, and Certificates of Fitnesses must be available on the premise, and made available to Fire Department representatives upon request.

Inspections will vary depending on the location, operation conditions and practices, and on the equipment installed; however, the following general inspection guidelines will apply for all locations for the operator and FDNY inspection standards:

- Fire safety regulations, protection systems, and plans are maintained, and emergency stop and shutdown systems must be functional. **FIRE PREVENTION AND PROTECTION SYSTEMS ARE REQURED TO BE INSTALLED AND MAINTAINED IN THE**

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CO-GEN PLANT. The fire safety system is implemented and maintained based on prescribed procedure from licensed engineers and the Fire Department. This includes, but not limited to: E-stops, fire and gas detection system, and CO2 suppression systems. The Letter of Approval from FDNY to each specific Co-Gen premises details the necessary safety measures and design requirements after papers and plans are reviewed, and process hazard studies are conducted.

- The entire premise must be checked daily for potential signs of equipment malfunction and gas leaks.
- Any potential malfunction or hazard where Co-Gen systems are operated must be corrected immediately by a representative of the manufacturer, manufacturer-trained maintenance crew, 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, properly repaired, or switched to backup systems; hazards may be presented by exposed electrical wires, etc.
- Rubbish and other combustible waste should not to be allowed to accumulate indoors. These are fire hazards, and may be easily ignited. All rubbish and other combustible waste should be promptly removed from the premises.
- Manufacturer's 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 shall all be ensured.
- Proper storage and handling of flammable compounds, such as lube oil, away from incompatible materials, electrical room, or long-term storage shall be maintained.

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APPENDIX

COMPANY NAME
BUSINESS ADDRESS

Date: _____

Fire Department
Bureau of Fire Prevention
9 Metro Tech Center
Brooklyn, NY 11201-3857

To whom it may concern:

The purpose of this letter is to document the applicant (full name of applicant) qualifications for a G-91 Certificate of Fitness. (Name of applicant) is currently employed by (name and address of employer). (Name of applicant) has been operating and managing this co-gen plant for (amount of time employed).

Applicant has been trained on the equipment utilized at this co-gen plant located at (premises address) which includes (the model number (if available) of the co-gen system install and list of all the major equipment of the system). The applicant is familiar with all safety procedures for the equipment installed at the COF applicants' work place.

Applicant is of GOOD CHARACTER and is PHYSICALLY ABLE to perform the functions required by the holder of this Certificate of Fitness.

_____	_____	_____
(Printed name of Employer)	(Employer's title)	(Signature of Employer)

NOTE: ***The recommendation letter should be on employer's letterhead. If not on employer's letterhead, signature must be notarized.***

SAMPLE

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