



Connecticut Department of

**ENERGY &
ENVIRONMENTAL
PROTECTION**

**BUREAU OF AIR MANAGEMENT
NEW SOURCE REVIEW PERMIT
TO CONSTRUCT AND OPERATE A STATIONARY SOURCE**

Issued pursuant to Title 22a of the Connecticut General Statutes (CGS) and Section 22a-174-3a of the Regulations of Connecticut State Agencies (RCSA).

Owner/Operator:	Yale University
Address:	135 College Street, 1 th Floor New Haven, CT 06510-2411
Equipment Location:	Central Power Plant, 120 Tower Parkway, New Haven, CT
Equipment Description:	Cogeneration System No. 2 Consisting of a General Electric PGT-5/M Gas Turbine, Forney Duct Burner and Keystone Unfired Heat Recovery Steam Generator
Collateral Conditions:	Part VIII includes collateral conditions which apply to permits 117-0204 through 117-0210

Town-Permit Numbers:	117-0205
Town-Premises Numbers:	117-0048
Prior Permit Issue Dates:	July 1, 1997 (permit to construct & operate)
Modification Issue Date:	August 19, 2011
Expiration Date:	None

/s/ Anne Gobin for
Daniel C. Esty
Commissioner

August 19, 2011
Date

PERMIT FOR FUEL BURNING EQUIPMENT

DEPARTMENT OF ENERGY AND ENVIRONMENTAL PROTECTION BUREAU OF AIR MANAGEMENT

This permit specifies necessary terms and conditions for the operation of this equipment to comply with state and federal air quality standards. The Permittee shall at all times comply with the terms and conditions stated herein.

PART I. DESIGN SPECIFICATIONS

A. General Description

Yale University operates the Central Power Plant to provide heat and electricity for the campus. This combined-cycle cogeneration system is designed to generate 6.1 MW of electricity and approximately 60,000 pounds of steam per hour.

B. Equipment Design Specifications

Turbine

1. Maximum Fuel Firing Rates¹: 69.5 MCF/hr (natural gas)
500 gal/hr (No. 2 oil)
2. Maximum Gross Heat Input (MMBTU/hr): 69.5

Duct Burner

3. Maximum Fuel Firing Rates¹: 66.7 MCF/hr (natural gas)
432 gal/hr (No. 2 oil)
4. Maximum Gross Heat Input (MMBTU/hr): 66.7

¹ at ISO conditions: 288 Kelvin, 60 percent relative humidity and 101.3 kilopascals pressure.

C. Control Equipment Design Specifications

1. The Forney Duct Burner is a Low NOx Burner
2. Selective Catalytic Reduction (SCR)
 - a. Make and Model: Hitachi-America, Ltd; Peerless
 - b. Catalyst Type: Base Metal Ceramic (TiO₂/V₂O₅)
3. Oxidation Catalyst
 - a. Make and Model: Englehard, Kamet
 - b. Catalyst Type: Aluminum Oxide & Platinum

D. Stack Parameters

1. Minimum Stack Height (ft): 150
2. Minimum Stack Exit Diameter (ft): 7
3. Minimum Exhaust Gas Flow Rate at 100% load (acfm): 65,302
4. Minimum Stack Exit Temperature at 100% load (°F): 290
5. Minimum Distance from Stack to Property Line (ft): 75

FIRM NAME: Yale University
EQUIPMENT LOCATION: Central Power Plant, 120 Tower Parkway, New Haven, CT
EQUIPMENT DESCRIPTION: General Electric PGT-5/M Gas Turbine, Forney Duct Burner & Keystone Heat Recovery Steam Generator, Cogeneration System No. 2

PERMIT FOR FUEL BURNING EQUIPMENT

DEPARTMENT OF ENERGY AND ENVIRONMENTAL PROTECTION BUREAU OF AIR MANAGEMENT

PART II. OPERATIONAL CONDITIONS

A. Operating Limits

Turbine and Duct Burner

1. Fuel Types: Natural Gas, No. 2 Oil
2. Maximum Fuel Consumption over any Consecutive 12 Month Period:
 - a. 1,489,200 MMBTU when operating solely on Natural Gas;
 - b. 5,356,835 gallons when operating solely on No. 2 Oil;
 - c. Total MMBTU shall be limited by the following equation:

$$x \left(0.139 \frac{\text{MMBTU}}{\text{gallon}} \right) + y \left(0.001 \frac{\text{MMBTU}}{\text{ft}^3} \right) \leq 1,489,200 \text{ MMBTU}$$

where,

- x is the gallons of No. 2 oil used over the previous 12 months; x shall not exceed 5,356,835 gallons
 y is the cubic feet of natural gas used over the previous 12 months; y shall not exceed 1,489.2 MMCF

3. Maximum Oil Sulfur Content (% by weight, dry basis): 0.05

PART III. CONTINUOUS EMISSION MONITORING REQUIREMENTS AND ASSOCIATED EMISSION LIMITS

The Permittee shall comply with the CEM requirements as set forth in RCSA Section 22a-174-4. CEM shall be required for the following pollutant/operational parameters and enforced on the following basis:

<u>Pollutant/Operational Parameter</u>	<u>Averaging Times</u>	<u>Emission Limit</u>
NO _x	24 hour rolling	6 ppmvd @15% O ₂
O ₂	1 hour block	

PART IV. MONITORING, RECORD KEEPING AND REPORTING REQUIREMENTS

A. Monitoring

1. The Permittee shall use a fuel metering device to continuously monitor fuel feed to the turbine and duct burner.

FIRM NAME: Yale University
EQUIPMENT LOCATION: Central Power Plant, 120 Tower Parkway, New Haven, CT
EQUIPMENT DESCRIPTION: General Electric PGT-5/M Gas Turbine, Forney Duct Burner & Keystone Heat Recovery Steam Generator, Cogeneration System No. 2

PERMIT FOR FUEL BURNING EQUIPMENT

**DEPARTMENT OF ENERGY AND ENVIRONMENTAL PROTECTION
BUREAU OF AIR MANAGEMENT**

**PART IV. MONITORING, RECORD KEEPING AND REPORTING REQUIREMENTS,
continued**

2. The Permittee shall continuously monitor and continuously record the SCR aqueous ammonia injection rate (lb/hr), operating temperature (°F) and pressure drop (inches of water) across the catalyst bed. The Permittee shall maintain these parameters within the ranges recommended by the manufacturer to achieve compliance with the emission limits in this permit.
3. The Permittee shall continuously monitor and continuously record the oxidation catalyst inlet temperature (°F). The Permittee shall maintain this parameter within the range recommended by the manufacturer to achieve compliance with the emission limits in this permit.
4. The Permittee shall perform inspections of the SCR and oxidation catalysts as recommended by the manufacturer.

B. Record Keeping

1. The Permittee shall keep records of monthly and consecutive 12 month fuel consumption. The consecutive 12 month fuel consumption shall be determined by adding (for each fuel) the current month's fuel consumption to that of the previous 11 months. The Permittee shall make these calculations within 30 days of the end of the previous month.
2. The Permittee shall keep records of the fuel certification for each delivery of fuel oil from a bulk petroleum provider or a copy of the current contract with the fuel supplier supplying the fuel used by the equipment that includes the applicable sulfur content of the fuel as a condition of each shipment. The shipping receipt or contract shall include the date of delivery, the name of the fuel supplier, type of fuel delivered, the percentage of sulfur in such fuel, by weight, dry basis, and the method used to determine the sulfur content of such fuel.
3. The Permittee shall calculate and record the monthly and consecutive 12 month PM-10/PM-2.5, SO₂, NO_x, CO, and VOC emissions in units of tons. The consecutive 12 month emissions shall be determined by adding (for each pollutant) the current month's emissions to that of the previous 11 months. Such records shall include a sample calculation for each pollutant. The Permittee shall make these calculations within 30 days of the end of the previous month.

FIRM NAME: Yale University
EQUIPMENT LOCATION: Central Power Plant, 120 Tower Parkway, New Haven, CT
EQUIPMENT DESCRIPTION: General Electric PGT-5/M Gas Turbine, Forney Duct Burner & Keystone Heat Recovery Steam Generator, Cogeneration System No. 2

PERMIT FOR FUEL BURNING EQUIPMENT

DEPARTMENT OF ENERGY AND ENVIRONMENTAL PROTECTION BUREAU OF AIR MANAGEMENT

PART IV. MONITORING, RECORD KEEPING AND REPORTING REQUIREMENTS, continued

Emissions during startup and shutdown shall be counted towards the annual emission limitation in Part VI.C of this permit.

4. The Permittee shall calculate and record the NO_x emissions from permits 117-0204 through 117-0210, inclusively.
5. The Permittee shall keep records of all exceedances of any emissions limitation or operating parameter. Such records shall include:
 - a. the date and time of the exceedance,
 - b. a detailed description of the exceedance, and
 - c. the duration of the exceedance.
6. The Permittee shall keep records of the occurrence and duration of any startup, shutdown, or malfunction in the operation of the stationary gas turbine/duct burner; any malfunction of the air pollution control equipment; or any periods during which a continuous monitoring system or monitoring device is inoperative. [40 CFR §60.7(b)]

Such records shall contain the following information:

- a. type of event (startup, shutdown, or malfunction),
 - b. equipment affected,
 - c. date of event,
 - d. duration of event (minutes),
 - e. fuel being used during event, and
 - f. total NO_x emissions emitted (lb) during the event.
7. The Permittee shall keep records of each delivery of aqueous ammonia. The records shall include the date of delivery, the name of the supplier, the quantity of aqueous ammonia delivered, and the percentage of ammonia in solution, by weight.
 8. The Permittee shall keep records of the inspection and maintenance of the SCR and oxidation catalysts. The records shall include the name of the inspector, the date, the results or actions and the date the catalyst is replaced.
 9. The Permittee shall keep all records required by this permit for a period of no less than five years and shall submit such records to the commissioner upon request.

FIRM NAME: Yale University
 EQUIPMENT LOCATION: Central Power Plant, 120 Tower Parkway, New Haven, CT
 EQUIPMENT DESCRIPTION: General Electric PGT-5/M Gas Turbine, Forney Duct Burner & Keystone Heat Recovery Steam Generator, Cogeneration System No. 2

PERMIT FOR FUEL BURNING EQUIPMENT

**DEPARTMENT OF ENERGY AND ENVIRONMENTAL PROTECTION
BUREAU OF AIR MANAGEMENT**

**PART IV. MONITORING, RECORD KEEPING AND REPORTING REQUIREMENTS,
continued**

C. Reporting

1. The Permittee shall notify the commissioner in writing of any exceedance of an emissions limitation or operating parameter, and shall identify the cause or likely cause of such exceedance, all corrective actions and preventive measures taken with respect thereto, and the dates of such actions and measures as follows:
 - a. For any hazardous air pollutant, no later than 24 hours after such exceedance commenced; and
 - b. For any other regulated air pollutant or operating parameter, no later than ten days after such exceedance commenced.

2. The Permittee shall notify the commissioner in writing of any malfunction of the stationary gas turbine/duct burner, the air pollution control equipment or the continuous monitoring system. The Permittee shall submit such notification within ten days of the malfunction. The notification shall include the following:
 - a. a description of the malfunction and a description of the circumstances surrounding the cause or likely cause of such malfunction, and
 - b. a description of all corrective actions and preventive measures taken and/or planned with respect to such malfunction and the dates of such actions and measures.

PART V. OPERATION AND MAINTENANCE REQUIREMENTS

- A.** The Permittee shall operate and maintain this equipment in accordance with the manufacturer's specifications and written recommendations. The Permittee shall operate and maintain this stationary combustion turbine/duct burner, air pollution control equipment, and monitoring equipment in a manner consistent with good air pollution control practices for minimizing emissions at all times including during startup, shutdown, and malfunction.

- B.** The Permittee shall properly operate the control equipment at all times that this turbine/duct burner is in operation and emitting air pollutants.

FIRM NAME: Yale University
EQUIPMENT LOCATION: Central Power Plant, 120 Tower Parkway, New Haven, CT
EQUIPMENT DESCRIPTION: General Electric PGT-5/M Gas Turbine, Forney Duct Burner & Keystone Heat Recovery Steam Generator, Cogeneration System No. 2

PERMIT FOR FUEL BURNING EQUIPMENT

DEPARTMENT OF ENERGY AND ENVIRONMENTAL PROTECTION BUREAU OF AIR MANAGEMENT

PART VI. ALLOWABLE EMISSION LIMITS

The Permittee shall not cause or allow this equipment to exceed the emission limits stated herein:

A. Short Term Emission Limits

These short term emission limits do not apply during periods of startup, shutdown and routine maintenance, unless otherwise noted.

TURBINE & DUCT BURNER OPERATING ON NATURAL GAS

Criteria	ppmvd		
Pollutants	@15% O ₂	lb/MMBTU	lb/hr
PM-10/PM-2.5		0.0204	2.78
SO ₂		0.0010	0.14
NOx	6	0.0286	3.90
VOC/HC		0.0223	3.04
CO		0.0136	1.85

TURBINE & DUCT BURNER OPERATING ON NO. 2 OIL

PM-10/PM-2.5		0.0417	5.40
SO ₂		0.052	6.74
NOx	6	0.0289	3.74
VOC/HC		0.0372	4.82
CO		0.0147	1.90

FOR ALL OPERATING SCENARIOS

Pollutants	ppmvd @15% O ₂
Ammonia	10

B. Startup and Shutdown

The Permittee shall minimize emissions during periods of startup and shutdown by the following work practices and time constraints. Start the ammonia injection as soon as minimum catalyst temperature is reached. The oxidation catalyst will not be bypassed during startup or shutdown. The duration of startup shall not exceed 60 minutes for a hot start or a warm start, nor 240 minutes for a cold start. A hot start shall be defined as startup when the turbine has been down for less than 8 hours. A warm start shall be defined as startup when the turbine has been down for more than 8 hours. A cold start shall be defined as startup when the turbine has been down for more than 24 hours. The duration of shutdown shall not exceed 30 minutes. Emissions during these periods shall be counted towards the annual emission limits stated herein.

FIRM NAME: Yale University
 EQUIPMENT LOCATION: Central Power Plant, 120 Tower Parkway, New Haven, CT
 EQUIPMENT DESCRIPTION: General Electric PGT-5/M Gas Turbine, Forney Duct Burner & Keystone Heat Recovery Steam Generator, Cogeneration System No. 2

PERMIT FOR FUEL BURNING EQUIPMENT

**DEPARTMENT OF ENERGY AND ENVIRONMENTAL PROTECTION
BUREAU OF AIR MANAGEMENT**

PART VI. ALLOWABLE EMISSION LIMITS, continued

C. Annual Emission Limits

Criteria	tons per 12
<u>Pollutants</u>	<u>consecutive months</u>
PM-10/PM-2.5	15.0
SO ₂	19.7
NO _x	12.4
VOC/HC	14.7
CO	5.1

- D. Hazardous Air Pollutants:** This equipment shall not cause an exceedance of the Maximum Allowable Stack Concentration (MASC) for any hazardous air pollutant (HAP) emitted and listed in RCOSA Section 22a-174-29. [**STATE ONLY REQUIREMENT**]

Demonstration of compliance with the above emission limits shall be met by calculating the emission rates using emission factors from the following sources:

1. NO_x: Most current CEM data.
2. PM-10/PM-2.5, VOC, CO, Ammonia: Most current DEP approved stack test data.
3. SO₂, HAPs: Compilation of Air Pollutant Emission Factors, AP-42, fifth edition, Section 3.1, April 2000 (turbine), Section 1.3, May 2010 (No. 2 oil, duct burner) and Section 1.4, July 1998 (natural gas, duct burner).

The commissioner may require other means (e.g. stack testing) to demonstrate compliance with the above emission limits, as allowed by state or federal statute, law or regulation.

PART VII. STACK EMISSION TEST REQUIREMENTS

FIRM NAME: Yale University
 EQUIPMENT LOCATION: Central Power Plant, 120 Tower Parkway, New Haven, CT
 EQUIPMENT DESCRIPTION: General Electric PGT-5/M Gas Turbine, Forney Duct Burner & Keystone Heat Recovery Steam Generator, Cogeneration System No. 2

Town No: 117 Premises No: 0048 Permit No: 0205 Stack No: 5

PERMIT FOR FUEL BURNING EQUIPMENT**DEPARTMENT OF ENERGY AND ENVIRONMENTAL PROTECTION
BUREAU OF AIR MANAGEMENT**

(Applicable if -X- Checked)

Stack testing shall be performed in accordance with the latest Emission Test Guidelines available on the DEP website:

http://www.ct.gov/dep/cwp/view.asp?a=2684&q=322076&depNav_GID=1619

Stack testing shall be required for the following pollutants:

PM-10/PM-2.5 SO₂ NO_x CO VOC Opacity

Other (HAPs): Ammonia

Stack testing shall be conducted for the following operating modes: turbine and duct burner on natural gas; and turbine and duct burner on No. 2 oil.

Recurrent stack testing for CO, VOC and ammonia shall be conducted within five years from the date of the previous stack test to demonstrate compliance with their respective limits.

Stack test results shall be reported as follows: all pollutants in units of lb/hr, CO and ammonia in units of ppmvd at 15% O₂.

PART VIII. SPECIAL REQUIREMENTS

- A. The Permittee shall comply with all applicable sections of the following New Source Performance Standard at all times.

Title 40 CFR Part 60, Subparts Dc, GG and A.

Copies of the Code of Federal Regulations (CFR) are available online at the U.S. Government Printing Office website.

- B. STATE ONLY REQUIREMENT: The Permittee shall operate this facility at all times in a manner so as not to violate or contribute significantly to the violation of any applicable state noise control regulations, as set forth in RCSA §§22a-69-1 through 22a-69-7.4.
- C. Total annual NO_x emissions from permits 117-0204 through 117-0210, inclusively, shall not exceed 121.5 tons per year.

PART IX. ADDITIONAL TERMS AND CONDITIONS

FIRM NAME: Yale University
EQUIPMENT LOCATION: Central Power Plant, 120 Tower Parkway, New Haven, CT
EQUIPMENT DESCRIPTION: General Electric PGT-5/M Gas Turbine, Forney Duct Burner & Keystone Heat Recovery Steam Generator, Cogeneration System No. 2

Town No: 117 Premises No: 0048 Permit No: 0205 Stack No: 5

PERMIT FOR FUEL BURNING EQUIPMENT

DEPARTMENT OF ENERGY AND ENVIRONMENTAL PROTECTION BUREAU OF AIR MANAGEMENT

- A. This permit does not relieve the Permittee of the responsibility to conduct, maintain and operate the regulated activity in compliance with all applicable requirements of any federal, municipal or other state agency. Nothing in this permit shall relieve the Permittee of other obligations under applicable federal, state and local law.
- B. Any representative of the DEP may enter the Permittee's site in accordance with constitutional limitations at all reasonable times without prior notice, for the purposes of inspecting, monitoring and enforcing the terms and conditions of this permit and applicable state law.
- C. This permit may be revoked, suspended, modified or transferred in accordance with applicable law.
- D. This permit is subject to and in no way derogates from any present or future property rights or other rights or powers of the State of Connecticut and conveys no property rights in real estate or material, nor any exclusive privileges, and is further subject to any and all public and private rights and to any federal, state or local laws or regulations pertinent to the facility or regulated activity affected thereby. This permit shall neither create nor affect any rights of persons or municipalities who are not parties to this permit.
- E. Any document, including any notice, which is required to be submitted to the commissioner under this permit shall be signed by a duly authorized representative of the Permittee and by the person who is responsible for actually preparing such document, each of whom shall certify in writing as follows: "I have personally examined and am familiar with the information submitted in this document and all attachments thereto, and I certify that based on reasonable investigation, including my inquiry of those individuals responsible for obtaining the information, the submitted information is true, accurate and complete to the best of my knowledge and belief. I understand that any false statement made in the submitted information may be punishable as a criminal offense under section 22a-175 of the Connecticut General Statutes, under section 53a-157b of the Connecticut General Statutes, and in accordance with any applicable statute."

PART IX. ADDITIONAL TERMS AND CONDITIONS, continued

- F. Nothing in this permit shall affect the commissioner's authority to

FIRM NAME: Yale University
 EQUIPMENT LOCATION: Central Power Plant, 120 Tower Parkway, New Haven, CT
 EQUIPMENT DESCRIPTION: General Electric PGT-5/M Gas Turbine, Forney Duct Burner & Keystone Heat Recovery Steam Generator, Cogeneration System No. 2

PERMIT FOR FUEL BURNING EQUIPMENT

**DEPARTMENT OF ENERGY AND ENVIRONMENTAL PROTECTION
BUREAU OF AIR MANAGEMENT**

institute any proceeding or take any other action to prevent or abate violations of law, prevent or abate pollution, recover costs and natural resource damages, and to impose penalties for violations of law, including but not limited to violations of this or any other permit issued to the Permittee by the commissioner.

- G.** Within 15 days of the date the Permittee becomes aware of a change in any information submitted to the commissioner under this permit, or that any such information was inaccurate or misleading or that any relevant information was omitted, the Permittee shall submit the correct or omitted information to the commissioner.
- H.** The date of submission to the commissioner of any document required by this permit shall be the date such document is received by the commissioner. The date of any notice by the commissioner under this permit, including but not limited to notice of approval or disapproval of any document or other action, shall be the date such notice is personally delivered or the date three days after it is mailed by the commissioner, whichever is earlier. Except as otherwise specified in this permit, the word "day" means calendar day. Any document or action which is required by this permit to be submitted or performed by a date which falls on a Saturday, Sunday or legal holiday shall be submitted or performed by the next business day thereafter.
- I.** Any document required to be submitted to the commissioner under this permit shall, unless otherwise specified in writing by the commissioner, be directed to: Office of Director; Engineering & Enforcement Division; Bureau of Air Management; Department of Environmental Protection; 79 Elm Street, 5th Floor; Hartford, Connecticut 06106-5127.

FIRM NAME: Yale University
EQUIPMENT LOCATION: Central Power Plant, 120 Tower Parkway, New Haven, CT
EQUIPMENT DESCRIPTION: General Electric PGT-5/M Gas Turbine, Forney Duct Burner & Keystone Heat Recovery Steam Generator, Cogeneration System No. 2
