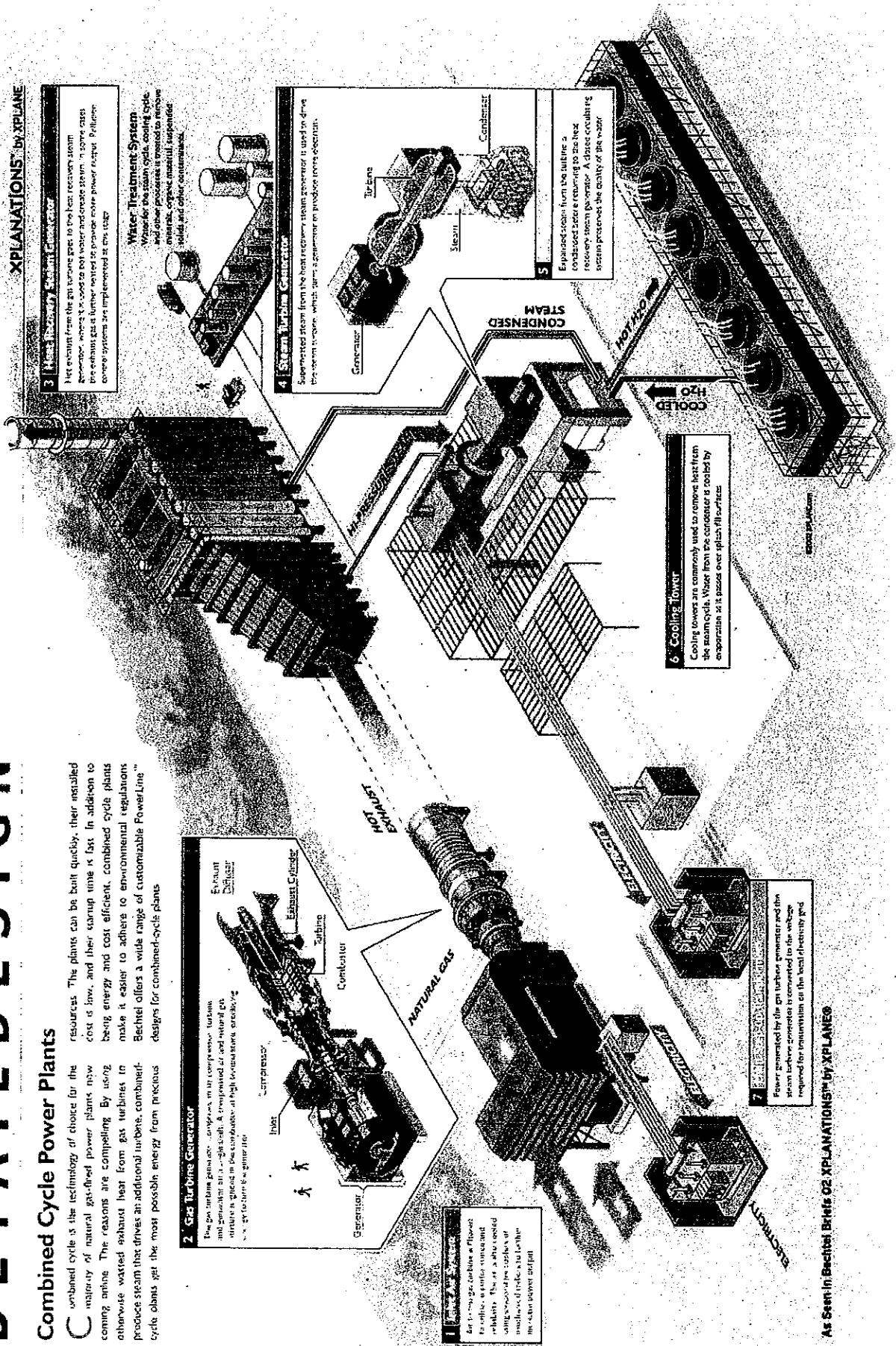




DETAILED DESIGN

Combined Cycle Power Plants

Combined cycle is the technology of choice for the majority of natural gas-fired power plants now coming online. The reasons are compelling. By using otherwise wasted exhaust heat from gas turbines to produce steam that drives an additional turbine, combined-cycle plants get the most possible energy from precious resources. The plants can be built quickly, their installed cost is low, and their startup time is fast. In addition to being energy and cost efficient, combined cycle plants make it easier to adhere to environmental regulations. Bechtel offers a wide range of customizable PowerLine™ designs for combined-cycle plants.



1. Heat Recovery Steam Generator

Hot exhaust from the gas turbine goes to the heat recovery steam generator, where it is used to heat water and create steam. In some cases the exhaust gas is further heated to produce extra power output. Pollution control systems are implemented at this stage.

2. Gas Turbine Generator

The gas turbine generator converts its compressed turbine and generator air into shaft work. A compressed air and natural gas mixture is ignited in the combustor at high temperatures, creating a high-speed gas flow.

3. Steam Turbine Generator

Superheated steam from the heat recovery steam generator is used to drive this second turbine, which runs a generator to produce electricity.

4. Condenser

Expanded steam from the turbine is condensed back into water in the heat recovery steam generator. A closed circulating system preserves the quality of the water.

5. Water Treatment System

Water for the steam cycle, cooling cycle and other processes is treated to remove minerals, organic material, suspended solids and other contaminants.

6. Cooling Tower

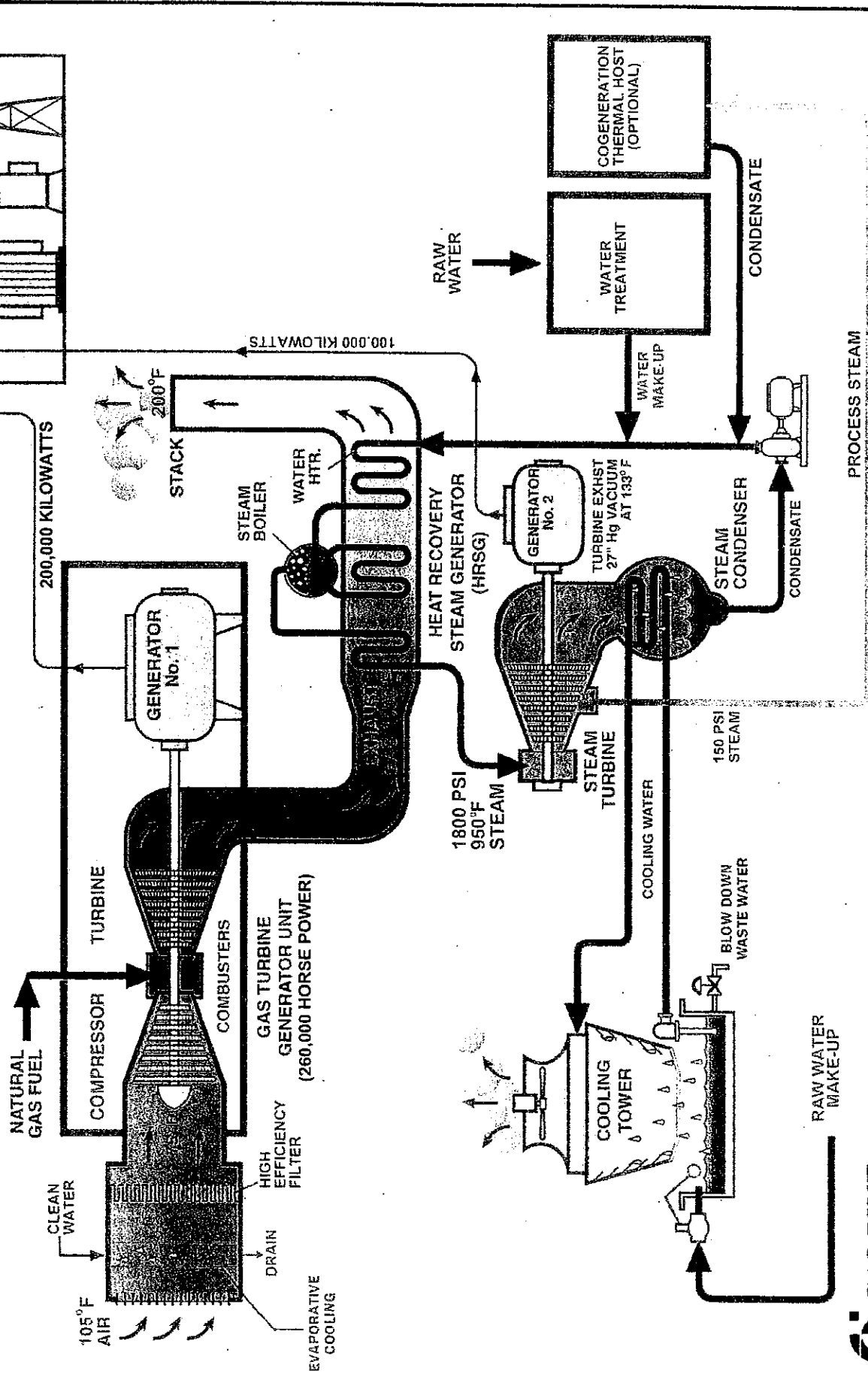
Cooling towers are commonly used to remove heat from the steam cycle. Water from the condenser is cooled by evaporation as it passes over splash fill surfaces.

7. Electrical Output

Power generated by the gas turbine generator and the steam turbine generator is converted to the voltage required for transmission on the local electricity grid.

As Seen in Bechtel Briefs 02: XPLANATIONS™ by XPLANE®

GAS TURBINE COMBINED CYCLE Power Plant System Schematic



Steam Injection

- Advantages
 - **Power Output Increases**
 - Up to ~20% for steam flow = 5% of air flow
 - **Heat Rate Decreases**
 - Compared to simple cycle
 - **Up to 80% Decrease in NOx**
 - **Lower Maintenance Costs than Water Injection** (less wear & tear on combustor liner and transition piece)

HANDOUT #3

Summary of Internal NOx Control Methods

	Water	Steam	DLN
Lowest NOx	25 ppm	25 ppm	10 - 25 ppm
Impact on CO	+	+	None
Impact on Power	+	+	None
Fuel Eff.	-	-/+	None
Cap Cost	Low	Medium	High

JOINT INSPECTION REQUIRED

LEGAL OWNER OR OPERATOR:

SJVU AQMD

MAILING ADDRESS:

HANDOUT # 5

LOCATION:

EQUIPMENT DESCRIPTION:

80 MW LOAD FOLLOWING POWER PLANT SERVED BY A 466 MMBTU/HR GENERAL ELECTRIC LM6000 SPRINT MODEL NATURAL GAS FIRED TURBINE WITH WATER INJECTION, A 234 MMBTU/HR JOHN ZINK LDRW-LE OR EQUIVALENT DUCT BURNER, A HEAT RECOVERY STEAM GENERATOR, A CONDENSING STEAM TURBINE, AN INLET AIR COOLING/FILTERING SYSTEM, A SELECTIVE CATALYTIC REDUCTION SYSTEM, AN OXIDATION CATALYST AND A LUBE OIL COALESCER

CONDITIONS

1. The permittee shall not begin actual onsite construction of the equipment authorized by this Authority to Construct until the lead agency satisfies the requirements of the California Environmental Quality Act (CEQA). [California Environmental Quality Act]
2. The permittee shall notify the District of the date of initiation of construction no later than 30 days after such date, the date of anticipated startup not more than 60 days nor less than 30 days prior to such date, and the date of actual startup within 15 days after such date. [District Rule 4001]
3. The exhaust stack exit shall be at least 90 feet in height, the exhaust shall be vertical and the stack exhaust flow shall not be impeded. [District Rule 2201]
4. The heat recovery steam generator shall provide space for additional selective catalytic reduction catalyst and additional oxidation catalyst. The additional space shall be sufficient to house the quantity of catalyst material necessary to achieve and maintain compliance with the emission limits of this permit. [District Rule 2201]
5. The gas turbine engine and generator lube oil vents shall be equipped with mist eliminators. Visible emissions from lube oil vents shall not exhibit opacity of 5% or greater except for up to three minutes in any hour. [District Rule 2201]
6. All equipment shall be maintained in proper operating condition and shall be operated in a manner to minimize emissions of air contaminants into the atmosphere. [District Rule 2201]
7. {118} No air contaminant shall be released into the atmosphere which causes a public nuisance. [District Rule 4102]
8. {14} Particulate matter emissions shall not exceed 0.1 grains/dscf in concentration. [District Rule 4201]
9. {15} No air contaminant shall be discharged into the atmosphere for a period or periods aggregating more than three minutes in any one hour which is as dark as, or darker than, Ringelmann 1 or 20% opacity. [District Rule 4101]
10. The gas turbine engine shall be equipped with a continuous monitoring system to measure and record hours of operation and fuel consumption. [District Rules 2201, 4001, and 4703]
11. The gas turbine engine shall be equipped with a continuous emission monitor (CEM) for NOx, CO, and O2. The CEM shall meet the requirements of 40 CFR part 60, Appendix B, Spec. 2 and 40 CFR part 75. The CEM shall be capable of monitoring emissions during startups and shutdowns as well as during normal operating conditions. [District Rules 2201, 4001, and 4703]
12. The CEM for NOx and O2 shall meet the applicable performance specification requirements in 40 CFR, Part 51, Appendix P and Part 60, appendix B, or shall meet equivalent specifications established by mutual agreement of the District, the ARB and the Environmental Protection Agency. [District Rule 1080]
13. The permittee shall monitor and record the NOx emission rate, the ammonia injection rate, the water injection rate, the exhaust temperature and the calculated exhaust flow rate. [District Rule 4703 and 4001]
14. The permittee shall continuously monitor and record the fuel consumption and the ratio of water injected to fuel fired. The system shall be accurate to within plus or minus 5% and shall be approved by the District. [District Rule 4001]

CEM

CEM

CONDITIONS FOR APPLICATION N-3233-4-0

INSPECTION
WORKSHEET

15. Results of continuous emissions monitoring shall be reduced according to the procedure established in 40 CFR, Part 51, Appendix P, paragraphs 5.0 through 5.3.3, or by other methods deemed equivalent by mutual agreement with the District, the ARB, and the EPA. [District Rule 1080]
16. Audits of continuous emission monitors shall be conducted quarterly, except during quarters in which relative accuracy and total accuracy testing was performed in accordance with EPA guidelines. The District shall be notified prior to completion of the audits. Audit reports shall be submitted to the District along with quarterly compliance reports. [District Rule 1080]
17. The exhaust stack shall be equipped with permanent provisions for stack gas sample collection. The sampling ports shall be located in accordance with the CARB regulation titled California Air Resources Board Air Monitoring Quality Assurance Volume VI, Standard Operating Procedures for Stationary Emission Monitoring and Testing. [District Rule 1081]
18. Start-up is defined as the period beginning with the initial firing of the turbine and ending when the turbine meets the NOx and CO limits for steady state operation. Shutdown is defined as the period beginning with initiation of the turbine shutdown sequence and ending with cessation of firing of the gas turbine. Start-up and shutdown durations shall not exceed 2 hours per day and 365 hours per calendar year. [District Rules 2201 and 4703]
19. The facility-wide CO emissions shall not exceed 199,999 pounds during any one calendar year. [District Rule 2201]
20. The facility-wide SOx emissions shall not exceed 54,750 pounds per year. [District Rule 2201]
21. The NOx emissions during start-up and shutdown periods shall not exceed 24.6 pounds during any one hour. [District Rule 2201]
22. The NOx emissions, except during start-up and shutdown periods, shall not exceed 2.5 ppmvd @ 15% O2 over a 1 hour rolling average. [District Rule 2201]
23. The CO emissions during start-up and shutdown periods shall not exceed 40.8 pounds during any one hour. [District Rule 2201]
- .. The CO emissions, except during start-up and shutdown periods, shall not exceed 6.0 ppmvd @ 15% O2 over a 3 hour rolling average. [District Rule 2201]
25. The VOC emissions shall not exceed 2.0 ppmvd, as methane, @ 15% O2 over a 3 hour rolling average. [District Rule 2201]
26. The PM10 emissions shall not exceed 2.5 pounds during any one hour while only the turbine is operating. [District Rule 2201]
27. The PM10 emission shall not exceed 3.0 pounds during any one hour while both the turbine and duct burner are operating. [District Rule 2201]
28. The gas turbine engine shall be fired exclusively on natural gas with a sulfur content of no greater than 0.25 grain of sulfur compounds (as S) per 100 dry scf of natural gas. [District Rule 2201]
29. The ammonia (NH3) emissions shall not exceed 10 ppmvd @ 15% O2 over a 24 hour rolling average. [District Rule 2201]
30. Ammonia slip shall be calculated utilizing the following procedure: ammonia slip ppmvd @ 15% O2 = $((a - (b \times c / 1,000,000)) \times (1,000,000 / b) \times d)$, where a = ammonia injection rate (lb/hr) / (17 lb/lb mol), b = dry exhaust flow rate (lb/hr) / (29 lb/lb mol), c = change in measured NOx concentration ppmvd @ 15% O2 across the catalyst and d = correction factor. The correction factor shall be derived annually during compliance testing by comparing the measured and calculated ammonia slip. Should the calculated ammonia slip value indicate a violation of the emission limit, source testing for ammonia slip shall be conducted with the turbine system operating under conditions similar to those it was operating at during the calculated violation. Source testing shall be conducted within 60 days of the calculated violation. Alternatively, the permittee may utilize a continuous in-stack ammonia monitor, acceptable to the District to monitor compliance. At least 60 days prior to using a NH3 CEM, the permittee shall submit a monitoring plan for District review and approval. [District Rule 4102]
31. Source testing to demonstrate compliance with the NOx, CO, VOC, PM10, NH3 and fuel gas sulfur content requirements of this permit shall be conducted within 60 days of initial operation. Source testing for NOx, CO, VOC, PM10 and NH3 shall be conducted at least once every twelve months thereafter. [District Rule 2201 and 4001]

32. Source testing to determine the percent efficiency of the turbine shall be conducted annually. [District Rule 4703]
- Testing to demonstrate compliance with the fuel sulfur content limit of this permit shall be conducted weekly. Once eight consecutive weekly tests show compliance, the fuel sulfur content testing frequency may be reduced to once every calendar quarter. If a quarterly test shows a violation of the sulfur content limit of this permit then weekly testing shall resume and continue until eight consecutive tests show compliance. Once compliance is shown on eight consecutive weekly tests then testing may return to quarterly. [District Rule 2201]
34. The District shall be notified at least 30 days prior to each test date and shall receive a source test plan at least 15 days prior to the test date. [District Rule 1081]
35. The results of each source test shall be received by the District no later than 60 days after the source test date. [District Rule 1081]
36. Source testing shall be witnessed or authorized by District personnel. [District Rule 1081]
37. Source testing for NO_x shall be conducted utilizing EPA method 7E or EPA method 20. [District Rules 4001 and 4703]
38. Source testing for CO shall be conducted utilizing EPA method 10 or EPA method 10 B. Alternative source testing methods will be allowed provided prior written approval is received from both the District and the EPA. [District Rule 4703]
39. Source testing for VOC shall be conducted utilizing EPA method 18 or EPA method 25. Alternative source testing methods will be allowed provided prior written approval is received from both the District and the EPA. [District Rule 2201]
40. Source testing to measure concentrations of PM₁₀ shall be conducted using EPA methods 201 and 202, or EPA methods 201A and 202, or CARB method 501 in conjunction with CARB method 5. Alternative source testing methods will be allowed provided prior written approval is received from both the District and the EPA. [District Rule 2201]
41. Source testing for stack O₂ content shall be conducted utilizing EPA method 3, EPA method 3A or EPA method 20. [District Rule 4703]
42. Testing for fuel sulfur content shall be conducted utilizing ASTM Method D 3246, ASTM Method D1072-90, ASTM Method D4468-85, ASTM Method D5504-94 or ASTM Method D3246-81. [District Rule 4001]
43. Source testing to determine the percent efficiency of the turbine shall be conducted utilizing the procedures in District Rule 4703 (Stationary Gas Turbines). [District Rule 4703]
44. The permittee shall maintain the following records: the date, time and duration of any malfunction of the continuous monitoring equipment; dates of performance testing; dates of evaluations, calibrations, checks, and adjustments of the continuous monitoring equipment; date and time period which a continuous monitoring system or monitoring device was inoperative. [District Rules 2201 and 4703]
45. The permittee shall maintain a daily record that includes the actual turbine start-up and stop times (local time), total hours of operation, and the quantity and type of fuel used. [District Rule 4703]
46. The permittee shall retain records of the cumulative annual facility-wide NO_x, CO and SO_x emissions. The record shall be updated daily. [District Rule 2201]
47. The permittee shall maintain hourly records of NO_x, CO and ammonia concentrations (ppmv @ 15% O₂). [District Rules 2201 and 4201]
48. The permittee shall submit a written report for each calendar quarter to the APCO. The report shall be received by the District within 30 days of the end of the quarter and shall include: time intervals and the magnitude of excess emissions, the nature and cause of excess emissions (if known), corrective actions taken and preventive measures adopted; averaging period used for data reporting corresponding to the averaging period specified in the emission test period used to determine compliance with an emission standard for the pollutant/source category in question; time and date of each period during which a continuous monitoring system was inoperative except for zero and span checks and the nature of system repairs and adjustments; a negative declaration when no excess emissions occurred. [District Rule 1080]

CONDITIONS FOR APPLICATION

7. All records required to be maintained by this permit shall be maintained for a period of five years and shall be made readily available for District inspection upon request. [District Rule 2201]
50. Permittee shall submit an application to comply with Rule 2520 (Federally Mandated Operating Permits prior to the implementation of this Authority to Construct to a Permit to Operate.) [District Rule 2520]
51. Permittee shall submit an application to comply with Rule 2540 (Acid Rain Program) at least 24 months prior to the date that the unit commences operation. [District Rule 2540]
52. Upon implementation of Authorities to Construct N-3233-4-0 and N-3233-5-0, emission offsets shall be provided for PM10. The offsets shall be provided at the offset ratio specified in District Rule 2201 (New and Modified Stationary Source Review). [District Rule 2201]
53. Offsets shall be provided in the amount that will mitigate the increase in PM10 emissions of 6,963 pounds per calendar quarter for the combined Authorities to Construct N-3233-4-0 and N-3233-5-0. [District Rule 2201]
54. SOx reductions may be utilized to offset PM10 emission increases. The combined distance/interpollutant offset ratio shall be 2.2 pounds of SOx per 1.0 pound of PM10 if the reductions occurred within 15 miles of the proposed facility. The combined distance/interpollutant offset ratio shall be 2.5 pounds of SOx per 1.0 pound of PM10 if the reductions occurred 15 miles or more from the proposed facility. [District Rule 2201]
55. Upon implementation of this Authority to Construct, emission offsets shall be provided for NOx and VOC. The offsets shall be provided at the offset ratio specified in District Rule 2201 (New and Modified Stationary Source Review). [District Rule 2201]
56. Offsets shall be provided in the amount that will mitigate the increase in NOx emissions of 14,585 pounds per calendar quarter and the increase in VOC emissions of 3,924 pounds per calendar quarter. [District Rule 2201]
57. The permittee shall submit to the District a plan for monitoring and recording the cumulative annual facility-wide CO and SOx emissions. The plan shall be received by the District at least 90 days prior to the planned start-up date and shall be approved by the District prior to the implementation of the plan. [District Rule 2201]
58. The permittee shall submit to the District information correlating the NOx control system operating parameters to the associated measured NOx output. The information must be sufficient to allow the District to determine compliance with the NOx emission limits of this permit during times that the CEMS is not functioning properly. [District Rule 4703]
59. The permittee shall obtain APCO approval for the use of any equivalent duct burner not specifically approved by this Authority to Construct. Approval of an equivalent duct burner shall only be made after the APCO's determination that the submitted design and performance data for the proposed alternate burner is equivalent to the approved burner. [District Rule 2201]
60. The permittee's request for approval of an equivalent duct burner shall include the following information: duct burner manufacturer and model number, maximum heat input rating, manufacturer's guaranteed emission concentrations and a description of low-NOx operation. [District Rule 2201]
61. The permittee's request for approval of an equivalent duct burner shall be submitted to the District at least 90 days prior to the planned installation date. The permittee shall also notify the District at least 30 days prior to the actual installation of the District approved equivalent duct burner. [District Rule 2201]
62. Authorities to Construct N-3233-1-2, N-3233-4-0 and N-3233-5-0 shall be implemented simultaneously. [District Rule 2201]