Memorandum

Florida Department of
Environmental Protection

TO: ~~Howard L. Rhodes~~ by aay

THRU: Al Linero aay 10/29

FROM: Syed Arif Syed Arif

DATE: October 29, 2002

SUBJECT: Miami-Dade Water & Sewer Department
Alexander Orr, Jr. WTP
Three Natural Gas Fueled Engine Driven Pump Sets

Attached for approval and signature is the final construction permit for MDWASD's Alexander Orr, Jr. Water Treatment Plant. The permit is to remove existing pumps and engines numbers 1 and 2, replacing the (pump/generator) capacity of engine number 1 with a diesel fueled engine driven emergency generator set and to replace existing diesel fueled engine driven pump numbers 3, 4 and 5 with three natural gas fueled engine driven pumps.

The existing pump engines are fuel oil fired. The replacement engines have significantly lower air pollutant emissions per unit of work. The replacement emergency generator is restricted to 500 hours of operation annually. This restriction will keep nitrogen oxides emissions below the PSD significance levels. With the exception of carbon monoxide, potential emissions from the new engines are not expected to significantly increase compared to the past actual emissions of the existing engines. Carbon monoxide emissions do not increase above the PSD significance levels. An air quality impact analysis was not required or conducted.

The original permitting was done in 1999. The units proposed in the previous permit were not installed, the emission increment was not consumed and this project replaces the previous one.

The applicant in response to the public notice submitted comments, which were satisfactorily responded to in the final determination.

October 29 is day 62 of the project.

I recommend your approval and signature.

Attachments

/sa

SENDER: *COMPLETE THIS SECTION*

- Complete items 1, 2, and 3. Also complete item 4 if Restricted Delivery is desired.
- Print your name and address on the reverse so that we can return the card to you.
- Attach this card to the back of the mailpiece, or on the front if space permits.

1. Article Addressed to:

Jorge S. Rodriguez, P.E.
Assistant Director - Water
Miami-Dade Water & Sewer Department
3071 SW 38th Avenue
Miami, FL 33146-1520

COMPLETE THIS SECTION ON DELIVERY

A. Received by *(Please Print Clearly)* S. MARTINEZ — B. Date of Delivery 10/2/02

C. Signature — ☐ Agent ☐ Addressee

D. Is delivery address different from item 1? ☐ Yes
If YES, enter delivery address below: ☐ No

3. Service Type
☑ Certified Mail ☐ Express Mail
☐ Registered ☐ Return Receipt for Merchandise
☐ Insured Mail ☐ C.O.D.

4. *Restricted Delivery? (Extra Fee)* ☐ Yes

2. 7001 0320 0001 3692 7911

PS Form 3811, July 1999 — *Domestic Return Receipt* — 102595-00-M-0952

U.S. Postal Service
CERTIFIED MAIL RECEIPT
(Domestic Mail Only; No Insurance Coverage Provided)

OFFICIAL USE

Postage	$
Certified Fee	
Return Receipt Fee (Endorsement Required)	
Restricted Delivery Fee (Endorsement Required)	
Total Postage & Fees	$

Postmark Here

Sent To Jorge S. Rodriguez
Street, Apt. No.; or PO Box No. 3071 SW 38th Ave.
City, State, ZIP+4 Miami, FL 33146-1520

7001 0320 0001 3692 7911

PS Form 3800, January 2001 — See Reverse for Instructions

SENDER: *COMPLETE THIS SECTION*

- Complete items 1, 2, and 3. Also complete item 4 if Restricted Delivery is desired.
- Print your name and address on the reverse so that we can return the card to you.
- Attach this card to the back of the mailpiece, or on the front if space permits.

1. Article Addressed to:

Jorge S. Rodriguez, P.E.
Assistant Director - Water
Miami-Dade Water & Sewer Department
3071 SW 38th Avenue
Miami, FL 33146-1520

COMPLETE THIS SECTION ON DELIVERY

A. Received by *(Please Print Clearly)* B. Date of Delivery 11/4/02

C. Signature
X [signature] ☐ Agent ☐ Addressee

D. Is delivery address different from item 1? ☐ Yes
If YES, enter delivery address below: ☐ No

3. Service Type
☑ Certified Mail ☐ Express Mail
☐ Registered ☐ Return Receipt for Merchandise
☐ Insured Mail ☐ C.O.D.

4. Restricted Delivery? *(Extra Fee)* ☐ Yes

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PS Form 3811, July 1999 Domestic Return Receipt 102595-00-M-0952

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CERTIFIED MAIL RECEIPT
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Postage	$
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Sent To: Jorge S. Rodriguez
Street, Apt. No.; or PO Box No. 3071 SW 38th Ave.
City, State, ZIP+4 Miami, FL 33146-1520

7001 0320 0001 3692 7720

PS Form 3800, January 2001 See Reverse for Instructions

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
NOTICE OF FINAL PERMIT

In the Matter of an
Application for Permit by:

Mr. Jorge S. Rodriguez, P.E., Asst. Director - Water
Miami-Dade Water & Sewer Department
3071 SW 38th Avenue
Miami, Florida 33146-1520

DEP File No. 0250314-005-AC
Alexander Orr, Jr. WTP
Natural Gas Fueled Engine Driven Pump Sets
Miami-Dade County

Enclosed is Final Permit Number 0250314-005-AC. This permit authorizes Miami-Dade Water & Sewer Department to remove existing pumps and engines numbers 1 and 2, replacing the (pump/generator) capacity of engine number 1 with a diesel fueled engine driven emergency generator set and to replace existing diesel fueled engine driven pump numbers 3, 4 and 5 with three natural gas fueled engine driven pumps at the Alexander Orr, Jr. water treatment plant. This permit is issued pursuant to Chapter 403, Florida Statutes.

Any party to this order has the right to seek judicial review of it under section 120.68 of the Florida Statutes, by filing a notice of appeal under rule 9.110 of the Florida Rules of Appellate Procedure with the clerk of the Department of Environmental Protection in the Office of General Counsel, Mail Station #35, 3900 Commonwealth Boulevard, Tallahassee, Florida, 32399-3000, and by filing a copy of the notice of appeal accompanied by the applicable filing fees with the appropriate District Court of Appeal. The notice must be filed within thirty days after this order is filed with the clerk of the Department.

Executed in Tallahassee, Florida.

A. A. Linero, P.E.
Bureau of Air Regulation

CERTIFICATE OF SERVICE

The undersigned duly designated deputy agency clerk hereby certifies that this Notice of Final Permit (including the Final permit) was sent by certified mail (*) and copies were mailed by U.S. Mail before the close of business on 10/30/02 to the person(s) listed:

Mr. Jorge S. Rodriguez, P.E., Miami-Dade WASD*
Mr. Richard O'Rourke, P.E., WASD (via e-mail)
Mr. Tom Tittle, DEP, SED
Mr. Patrick Wong, DERM

Clerk Stamp

FILING AND ACKNOWLEDGMENT FILED, on this date, pursuant to §120.52, Florida Statutes, with the designated Department Clerk, receipt of which is hereby acknowledged.

Victoria Gibson (Clerk) October 30, 2002 (Date)

FINAL DETERMINATION

Miami-Dade Water & Sewer Department
Alexander Orr, Jr. Water Treatment Plant
DEP File Number 0250314-005-AC

An Intent to Issue an Air Construction Permit Modification to Miami-Dade Water & Sewer Department (WASD) Alexander Orr, Jr. Water Treatment Plant, located at 6800 SW 87 Avenue, Miami, Miami-Dade County, Florida, was distributed on September 30, 2002. The Public Notice of Intent to Issue Air Construction Permit was published in the Miami Daily Business Review on October 2, 2002. Copies of the draft air construction permit were available for public inspection at the Department offices in West Palm Beach, Miami and Tallahassee.

The applicant submitted comments regarding specific conditions for the emergency generator. The comments and Department's responses are as follows:

Comment 1

1. Hours of Operation: WASD requests that this condition be changed to read: "1. Hours of Operation: The hours of operation for this emission unit shall not exceed 500 hours in any consecutive 12-month period."

Department's Response

The Department will change Specific Condition 1 of Emission Unit 023 as follows:

1. Hours of Operation: The hours of operation for this emission unit ~~may operate for~~ shall not exceed 500 ~~hours/year~~ hours in any consecutive 12-month period. [Rule 62-210.200, F.A.C., Definitions-potential to emit (PTE)]

Comment 2

2. Fuel: WASD requests that the last two sentences regarding fuel consumption be removed and the condition be revised to read: "2. Fuel: The emission unit shall be fired with diesel fuel with a maximum sulfur content of 0.05 percent, by weight. {Permitting note: At 100% engine load a Model 3508 engine fuel consumption is 66.5 gallons per hour, based on a 35-degree API diesel fuel with a higher heating value of 18,390 Btu/lb. On this basis, the fuel consumption for 500 hours of operation at 100 percent engine load is approximately 33,250 gallons.}"

Department's Response

The Department will change Specific Condition 2 of Emission Unit 023 as follows:

2. Fuel: The emission unit shall be fired with diesel fuel with a maximum sulfur content of 0.05 percent, by weight. ~~Fuel consumption shall not exceed 33,250 gallons of diesel fuel in any consecutive 12-month period. The owner or operator shall keep monthly records of total fuel consumption for the emission unit.~~ [Rule 62-210.200, F.A.C., Definitions-potential to emit (PTE)]

{Permitting note: At 100% engine load a Model 3508 engine fuel consumption is 66.5 gallons per hour, based on a 35-degree API diesel fuel with a higher heating value of 18,390 Btu/lb. On this basis, the fuel consumption for 500 hours of operation at 100 percent engine load is approximately 33,250 gallons.}

Comment 3

9. Fuel Consumption: WASD requests that this condition be changed to: "9. Hours of Operation: The owner or operator shall monitor the hours of operation of the emission units with an hour meter."

Department's Response

The Department will change Specific Condition 9 of Emission Unit 023 as follows:

9. ~~Fuel Consumption~~ Hours of Operation: The owner or operator shall monitor ~~fuel consumption by metering the fuel between the storage tank and the emission unit~~ the hours of operation of the emission unit with an hour meter. [Rule 62-4.070(3), F.A.C.]

Comment 4

10. Meter Fuel Calibration: WASD recommends that this condition be removed in its entirety.

Department's Response

The Department does not agree with the applicant's request. Since an hour meter is required to keep track of the hours of operation for this emission unit, the Department will require calibration of the hour meter in accordance with the manufacturer's schedule and recommendation. The Department will change Specific Condition as follows:

10. Hour Meter ~~Fuel~~ Calibration: Calibration of the ~~fuel~~ hour meter shall be conducted in accordance with manufacturer's schedule and recommendation. [Rule 62-4.070(3), F.A.C.]

The final action of the Department is to issue the permit with the changes noted above.

Department of Environmental Protection

Jeb Bush
Governor

Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

David B. Struhs
Secretary

PERMITTEE

Miami-Dade Water & Sewer Department
Alexander Orr, Jr. WTP

3071 SW 38th Avenue
Miami, Florida 33146-1520

Permit No.	0250314-005-AC
Project	Three Natural Gas Fueled Engine Driven Pump Sets
SIC No.	4941
Expires:	December 31, 2003

Authorized Representative:

Mr. Jorge S. Rodriguez, P.E.
Assistant Director – Water

PROJECT AND LOCATION

The permit authorizes Miami-Dade Water & Sewer Department to remove existing pumps and engines numbers 1 and 2, replacing the (pump/generator) capacity of engine number 1 with a diesel fueled engine driven emergency generator set and to replace existing diesel fueled engine driven pump numbers 3, 4 and 5 with three natural gas fueled engine driven pumps.

This facility is located at the Alexander Orr, Jr. Water Treatment Plant, 6800 SW 87 Avenue, Miami, Miami-Dade County. UTM coordinates are: Zone 17; 566.6 km E and 2843.5 km N.

STATEMENT OF BASIS

This construction permit is issued under the provisions of Chapter 403 of the Florida Statutes (F.S.), and the Florida Administrative Code (F.A.C.) Chapters 62-4, 62-204, 62-210, 62-212, 62-296, and 62-297. The above named permittee is authorized to perform the construction in accordance with the conditions of this permit and as described in the application, approved drawings, plans, and other documents on file with the Department of Environmental Protection (Department).

APPENDIX

The attached appendix is a part of this permit:

Appendix GC General Permit Conditions

for Howard L. Rhodes, Director
Division of Air Resources Management

FACILITY DESCRIPTION

This facility consists of a municipally owned water treatment plant providing potable water to the public.

PROJECT DETAILS

This permitting action is to remove existing pumps and engines numbers 1 and 2, replacing the (pump/generator) capacity of engine number 1 with a diesel fueled engine driven emergency generator set and to replace existing diesel fueled engine driven pump numbers 3, 4 and 5 with three natural gas fueled engine driven pumps. Emissions units that will be removed are 001 (engine and pump #1), 002 (engine and pump #2 which were previously removed from service), 003 (engine and pump #3), 004 (engine and pump #4), and 005 (engine and pump #5). Emissions units addressed by this permit are:

Emissions Unit No.	Emissions Unit Description
023[1]	1332 brake hp diesel fired Caterpillar Model 3508 TA-130, a 4-cycle turbocharged diesel internal combustion (IC) engine driving an electric generator prime rating 900 kW. Maximum heat input rate is 9.2 mmBtu/hr.
018[2]	810 brake hp natural gas fired Caterpillar Model G3512 LE-130 engine for pump 3. Maximum heat input rate is 6.00 mmBtu/hr. Pump has a designed 20 million gallons per day (MGD) water pumping capacity.
019[2]	810 brake hp natural gas fired Caterpillar Model G3512 LE-130 engine for pump 4. Maximum heat input rate is 6.00 mmBtu/hr. Pump has a designed 20 MGD water pumping capacity.
020[2]	2090 brake hp natural gas fired Caterpillar Model G3608 LE engine for pump 5. Maximum heat input rate is 13.70 mmBtu/hr. Pump has a designed 40 MGD water pumping capacity.

1 – New Emission Unit

2 – Previously Permitted Emission Units

REGULATORY CLASSIFICATION

This facility is classified as a Major or Title V Source of air pollution because emissions of at least one regulated air pollutant, such as particulate matter (PM/PM_{10}), sulfur dioxide (SO_2), nitrogen oxides (NOx), carbon monoxide (CO), or volatile organic compounds (VOC) exceeds 100 tons per year (TPY).

This facility is not within an industry included in the list of the 28 Major Facility Categories per Table 62-212.400-1, F.A.C. Because emissions are greater than 250 TPY for at least one criteria pollutant, the facility is also a Major Facility with respect to Rule 62-212.400, Prevention of Significant Deterioration (PSD).

This project is exempt from the requirements of Rule 62-212.400, F.A.C., Prevention of Significant Deterioration (PSD) as discussed in the Technical Evaluation and Preliminary Determination dated September 25, 2002.

The emission unit 023 in this project is subject to the Reasonable Available Control Technology (RACT) requirements of 62-296.570(4)(b)7 which limits the emissions of NOx to 4.75 lb/MMBtu from oil fired diesel generator.

The emissions units (18, 19 and 20) included in this project are not subject to any unit-specific emission limiting standard (considered "unregulated" for purposes of Title V permitting).

PERMIT SCHEDULE

- 05/13/02 Received application for construction permit
- 08/05/02 Permit application deemed complete
- 09/30/02 Distributed Notice of Intent to Issue permit
- 10/02/02 Notice of Intent published in Miami Daily Business Review

RELEVANT DOCUMENTS

The documents listed below are the basis of the permit. They are specifically related to this permitting action. These documents are on file with the Department.

- Application received at the Bureau of Air Regulation on May 13, 2002
- Department's letter dated June 10, 2002
- Applicant's response received August 5, 2002
- Department's Technical Evaluation and Preliminary Determination dated September 25, 2002
- Department's Intent to Issue and public notice information dated September 30, 2002
- Applicant's comments (e-mail letter) in response to the draft permit dated October 15, 2002

The following specific conditions apply to all emissions units at this facility addressed by this permit.

ADMINISTRATIVE

1. Regulating Agencies: All documents related to applications for permits to construct, operate or modify an emissions unit should be submitted to the Bureau of Air Regulation (BAR), Florida Department of Environmental Protection at Mail Station #5505, 2600 Blair Stone Road, Tallahassee, Florida 32399-2400, phone number 850/488-0114. All documents related to reports, tests, minor modifications and notifications shall be submitted to the Department's Southeast District office at PO Box 15425, West Palm Beach, Florida, 33416-5425, and phone number 561/681-6600. Copies of all documents should be sent also to the Air Quality Management Division, Miami-Dade County Department of Environmental Resources Management, Suite 900 33 SW Second Avenue, Miami, Florida 33130-1540.

2. General Conditions: The owner and operator is subject to and shall operate under the attached General Permit Conditions G.1 through G.15 listed in Appendix GC of this permit. General Permit Conditions are binding and enforceable pursuant to Chapter 403 of the Florida Statutes. [Rule 62-4.160, F.A.C.]

3. Terminology: The terms used in this permit have specific meanings as defined in the corresponding chapters of the Florida Administrative Code.

4. Applicable Regulations, Forms and Application Procedures: Unless otherwise indicated in this permit, the construction and operation of the subject emissions unit shall be in accordance with the capacities and specifications stated in the application. The facility is subject to all applicable provisions of Chapter 403, F.S. and Florida Administrative Code Chapters 62-4, 62-110, 62-204, 62-212, 62-213, 62-296, 62-297 and the Code of Federal Regulations Title 40, Part 60, adopted by reference in the Florida Administrative Code (F.A.C.) regulations. The permittee shall use the applicable forms listed in Rule 62-210.900, F.A.C. and follow the application procedures in Chapter 62-4, F.A.C. Issuance of this permit does not relieve the facility owner or operator from compliance with any applicable federal, state, or local permitting or regulations. [Rules 62-204.800, 62-210.300 and 62-210.900, F.A.C.]

5. New or Additional Conditions: Pursuant to Rule 62-4.080, F.A.C., for good cause shown and after notice and an administrative hearing, if requested, the Department may require the permittee to conform to new or additional conditions. The Department shall allow the permittee a reasonable time to conform to the new or additional conditions, and on application of the permittee, the Department may grant additional time. [Rule 62-4.080, F.A.C.]

6. Expiration: This air construction permit shall expire on **December 31, 2003**. The permittee, for good cause, may request that this construction permit be extended. Such a request shall be submitted to the Department's Bureau of Air Regulation prior to 60 days before the expiration of the permit. [Rules 62-210.300(1), 62-4.070(4), 62-4.080, and 62-4.210, F.A.C]

7. Modifications: No emissions unit or facility subject to this permit shall be constructed or modified without obtaining an air construction permit from the Department. Such permit must be obtained prior to the beginning of construction or modification. [Rules 62-210.300(1) and 62-212.300(1)(a), F.A.C.]

8. Title V Operation Permit Required: This permit authorizes construction and/or installation of the permitted emissions unit and initial operation to determine compliance with Department rules. A

Title V operation permit is required for regular operation of the permitted emissions unit. The owner or operator shall apply for and receive a Title V operation permit prior to expiration of this permit. To apply for a Title V operation permit, the applicant shall submit the appropriate application form, compliance test results, and such additional information as the Department may by law require. The application shall be submitted to the Department's Southeast District office. [Rules 62-4.030, 62-4.050, 62-4.220, and Chapter 62-213, F.A.C.]

EMISSION LIMITING STANDARDS

9. General Visible Emissions Standard: Except for emissions units that are subject to a particulate matter or opacity limit set forth or established by rule and reflected by conditions in this permit, no person shall cause, let, permit, suffer, or allow to be discharged into the atmosphere the emissions of air pollutants from any activity, the density if which is equal to or greater than that designated as Number 1 on the Ringelmann Chart (20% opacity). The test method for visible emissions shall be EPA Method 9, incorporated and adopted by reference in Chapter 62-297, F.A.C. Test procedures shall meet all applicable requirements of Chapter 62-297, F.A.C. [Rule 62-296.320(4)(b)1, F.A.C.]

10. General Pollutant Emission Limiting Standards: [Rule 62-296.320(2), F.A.C.]

    No person shall cause, suffer, allow or permit the discharge of air pollutants which cause or contribute to an objectionable odor.

    [Note: An objectionable odor is defined in Rule 62-210.200(198), F.A.C., as any odor present in the outdoor atmosphere which by itself or in combination with other odors, is or may be harmful or injurious to human health or welfare, which unreasonably interferes with the comfortable use and enjoyment of life or property, or which creates a nuisance.]

OPERATIONAL REQUIREMENTS

11. Plant Operation - Problems: If temporarily unable to comply with any of the conditions of the permit due to breakdown of equipment or destruction by hazard of fire, wind or by other cause, the permittee shall immediately notify the Department's district office and, if applicable, appropriate local program. The notification shall include pertinent information as to the cause of the problem, and what steps are being taken to correct the problem and to prevent its recurrence, and where applicable, the owner's intent toward reconstruction of destroyed facilities. Such notification does not release the permittee from any liability for failure to comply with Department rules. [Rule 62-4.130, F.A.C.]

12. Circumvention: No person shall circumvent any air pollution control device or allow the emission of air pollutants without the applicable air pollution control device operating properly. [Rule 62-210.650, F.A.C.]

13. Excess Emissions:

    (a) Excess emissions resulting from start-up, shutdown or malfunction of any emissions units shall be permitted providing (1) best operational practices to minimize emissions are adhered to and (2) the duration of excess emissions shall be minimized, but in no case exceed two hours in any 24 hour period unless specifically authorized by the Department for longer duration. [Rule 62-210.700(1), F.A.C.]

(b) Excess emissions which are caused entirely or in part by poor maintenance, poor operation, or any other equipment or process failure which may reasonably be prevented during start-up, shutdown, or malfunction shall be prohibited. [Rule 62-210.700(4), F.A.C.]

COMPLIANCE MONITORING AND TESTING REQUIREMENTS

14. Required Number of Test Runs: For mass emission limitations, a compliance test shall consist of three complete and separate determinations of the total air pollutant emission rate through the test section of the stack or duct and three complete and separate determinations of any applicable process variables corresponding to the three distinct time periods during which the stack emission rate was measured; provided, however, that three complete and separate determinations shall not be required if the process variables are not subject to variation during a compliance test, or if three determinations are not necessary in order to calculate the unit's emission rate. The three required test runs shall be completed within one consecutive five-day period. In the event that sample is lost or one of the three runs must be discontinued because of circumstances beyond the control of the owner or operator, and a valid third run cannot be obtained within the five-day period allowed form the test, the Secretary or his or her designee may accept the results of two complete runs as proof of compliance, provided that the arithmetic mean of the two complete runs is at least 20 percent below the allowable emission limiting standards. [Rule 62-297.310(1), F.A.C]

15. Operating Rate During Testing: Unless otherwise stated in the applicable emission limiting standard rule, testing of emission shall be conducted with the emission unit operation at permitted capacity. Permitted capacity is defined as 90 to 100 percent of the maximum operation rate allowed by the permit. If it is impractical to test at permitted capacity, an emission unit may be tested at less than the minimum permitted capacity; in this case, subsequent emission unit operation is limited to 110 percent of the test load until a new test is conducted. Once the unit is so limited, operation at higher capacities is allowed for no more than 15 consecutive days for the purpose of additional compliance testing to regain the authority to operate at the permitted capacity. [Rule 62-297.310(2), F.A.C.]

16. Calculation of Emission Rate: The indicated emission rate or concentration shall be the arithmetic average of the emission rate or concentration determined by each of the three separate test runs unless otherwise specified in a particular test method or applicable rule.

17. Test Procedures shall meet all applicable requirements of Rule 62-297.310(4), F.A.C. [Rule 62-297.310(4), F.A.C.]

18. Special Compliance Tests: When the Department, after investigation, has good reason (such as complaints, increased visible emissions or questionable maintenance of control equipment) to believe that any applicable emission standard contained in a Department rule or in a permit issued pursuant to those rules is being violated, it shall require the owner or operator of the facility to conduct compliance tests which identify the nature and quantity of pollutant emissions from the emissions units and to provide a report on the results of said tests to the Department. [Rule 62-297.310(7)(b), F.A.C.]

19. Determination of Process Variables.

(a) Required Equipment. The owner or operator of an emission unit for which compliance tests are required shall install, operate, and maintain equipment or instruments necessary to determine process

variables, such as process weight input or heat input, when such data are needed in conjunction with emission data to determine the compliance of the emission unit with applicable emission limiting standards.

(b) Accuracy of Equipment: Equipment or instruments used to directly or indirectly determine process variables, including devices such as belt scales, weight hoppers, flow meters, and tank scales, shall be calibrated and adjusted to indicate the true value of the parameter being measured with sufficient accuracy to allow the applicable process variable to be determined within 10% of its true value. [Rule 62-297.310(5), F.A.C.]

20. Required Stack Sampling Facilities: Sampling facilities include sampling ports, work platforms, access to work platforms, electrical power, and sampling equipment support. All stack sampling facilities must meet any Occupational Safety and Health Administration (OSHA) Safety and Health Standards described in 29 CFR Part 1910, Subparts D and E. Sampling facilities shall also conform to the requirements of Rule 62-297.310(6), F.A.C. See Appendix SS-1, Stack Sampling Facilities. [Rule 62-297.310(6), F.A.C.]

REPORTING AND RECORD KEEPING REQUIREMENTS

21. Test Notification: The owner or operator shall notify the Department's Southeast District office, Air Program and, if applicable, appropriate local program, at least 15 days prior to the date on which each formal compliance test is to begin. Notification shall include the date, time, and place of each such test, and the test contact person who will be responsible for coordinating and having such test conducted for the owner or operator. [Rule 62-297.310(7)(a)9, F.A.C.]

22. Duration of Record Keeping: Upon request, the permittee shall furnish all records and plans required under Department rules. During enforcement actions, the retention period for all records will be extended automatically unless otherwise stipulated by the Department. The permittee shall hold at the facility or other location designated by this permit records of all monitoring information (including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation) required by the permit, copies of all reports required by this permit, and records of all data used to complete the application for this permit. These materials shall be retained at least five years from the date of the sample, measurement, report, or application unless otherwise specified by Department rule. [Rules 62-4.160(14)(a)&(b) and 62-213.440(1)(b)2.b., F.A.C.]

23. Test Reports: The owner or operator of an emission unit for which a compliance test is required shall file a report with the Department on the results of each such test. The required test report shall be filed with the Department as soon as practical but no later than 45 days after the last sampling run of each test is completed. The test report shall provide sufficient detail on the emission unit tested and the test procedures used to allow the Department to determine if the test was properly conducted and the test results properly computed. As a minimum, the test report, other than for an EPA or DEP Method 9 test, shall provide the applicable information listed in Rule 62-297.310(8)(c),F.A.C. [Rule 62-297.310(8), F.A.C.]

24. Excess Emissions Report: If excess emissions occur, the owner or operator shall notify the Department within one working day of: the nature, extent, and duration of the excess emissions; the cause of the

excess emissions; and the actions taken to correct the problem. In addition, the Department may request a written summary report of the incident. Pursuant to the New Source Performance Standards, excess emissions shall also be reported in accordance with 40 CFR 60.7, Subpart A. [Rule 62-4.130, F.A.C.]

25. Excess Emissions Report - Malfunctions: In case of excess emissions resulting from malfunctions, each owner or operator shall notify the Department or the appropriate local program in accordance with Rule 62-4.130, F.A.C. A full written report on the malfunctions shall be submitted in a quarterly report if requested by the Department. [Rule 62-210.700(6), F.A.C.]

26. Annual Operating Report for Air Pollutant Emitting Facility: The Annual Operating Report for Air Pollutant Emitting Facility shall be completed each year and shall be submitted to the Department's Southeast District office and, if applicable, the appropriate local program by March 1 of the following year. [Rule 62-210.370(3), F.A.C.]

The following specific conditions apply to the following emission unit after construction:

Emissions Unit No.	Emissions Unit Description
023	1332 brake hp diesel fired Caterpillar Model 3508 TA-130, a 4-cycle turbocharged diesel internal combustion (IC) engine driving an electric generator prime rating 900 kW. Maximum heat input rate is 9.2 mmBtu/hr.

[Note: This emission unit is subject to the NOx RACT requirements of 62-296.570, F.A.C.]

OPERATIONAL REQUIREMENTS

1. Hours of Operation: The hours of operation for this emission unit shall not exceed 500 hours in any consecutive 12-month period. [Rule 62-210.200, F.A.C., Definitions-potential to emit (PTE)]

2. Fuel: The emission unit shall be fired with diesel fuel with a maximum sulfur content of 0.05 percent, by weight. [Rule 62-210.200, F.A.C., Definitions-potential to emit (PTE)]

   Permitting note: At 100% engine load a Model 3508 engine fuel consumption is 66.5 gallons per hour, based on a 35-degree API diesel fuel with a higher heating value of 18,390 Btu/lb. On this basis, the fuel consumption for 500 hours of operation at 100 percent engine load is approximately 33,250 gallons.

3. Operating Procedures: The emission unit shall be properly operated and maintained at all times in a condition to minimize emissions of air pollutants. The owner and operator shall ensure that all facility staff responsible for the emission unit is trained in the operation and maintenance in accordance with the guidelines and procedures as established by the equipment manufacturers. [Rule 62-4.070(3), F.A.C.]

EMISSION LIMITATIONS AND STANDARDS

4. Visible Emission: These emission units are subject to the General Visible Emission Standards. See condition 9 in Section II, Facility-Wide Specific Conditions. [Rule 62-296.320(4)(b), F.A.C.]

5. Nitrogen Oxides (NOx) Emission: Emission of NO_x shall not exceed 4.75 lb/MMBtu. [Rule 62-296.570(4)(b)7, F.A.C.]

COMPLIANCE MONITORING AND TESTING REQUIREMENTS

6. Visible Emission: Compliance with the visible emission limitation shall be determined each federal fiscal year (Oct.1-Sept.30) using EPA Method 9 contained in 40 CFR 60, Appendix A and adopted by reference in Rule 62-297, F.A.C. The minimum requirements for stationary point sources emission test procedures and reporting shall be in accordance with Rule 62-297, F.A.C. and 40 CFR 60 Appendix A. [Rule 62-297, F.A.C.]

7. Nitrogen Oxide (NOx) Emission Tests: Compliance with the emission limits for NOx of this permit shall be demonstrated each federal fiscal year (Oct.1-Sept. 30), if applicable, by using EPA Method 7 or 7E, as described in 40 CFR 60, Appendix A, adopted by reference in Rule 62-204.800, F.A.C., and adopted in Rule 62-297.401, F.A.C. Sampling of the exhaust gas shall be via a rake probe placed into the engine exhaust outlet. [Rules 62-4.070(3), 62-204.800, 62-297.310, and 62-297.401, F.A.C.]

8. Fuel Sulfur Content Tests: The owner or operator shall determine the sulfur content of each delivery of diesel fuel received for these emission units using ASTM D 4057-88, Standard Practice for Manual Sampling of Petroleum and Petroleum Products and one of the following test methods for sulfur in petroleum products: ASTM D 129-91, ASTM D 2622-94, or ASTM D 4294-90. These methods are adopted by Rule 62-297.440, F.A.C. The owner or operator may comply with this requirement by receiving records from the fuel supplier that indicate the sulfur content of the fuel delivered complies with the sulfur limit of specific condition 2. [Rules 62-4.070(3), 62-297.440, F.A.C.]

9. Fuel Consumption: The owner or operator shall monitor the hours of operation of the emission unit with an hour meter. [Rule 62-4.070(3), F.A.C.]

REPORTING AND RECORDKEEPING REQUIREMENTS

10. Hour Meter Calibration: Calibration of the hour meter shall be conducted in accordance with manufacturer's schedule and recommendation. [Rule 62-4.070(3), F.A.C.]

11. Fuel Sulfur Content Records: The owner or operator shall maintain records of sulfur content of each delivery of diesel fuel received for the emission unit. [Rule 62-4.070(3), F.A.C.]

12. Records of Maintenance: The owner or operator shall make and maintain records of maintenance sufficient to demonstrate compliance with the operating procedure requirements of specific condition 3 of this permit. [Rule 62-4.070(3), F.A.C.]

The following specific conditions apply to the following emissions units after construction:

Emissions Unit No.	Emissions Unit Description
018	810 brake hp natural gas fired Caterpillar Model G3512 LE-130 engine for pump 3. Maximum heat input rate is 6.00 mmBtu/hr. Pump has a designed 20 million gallons per day (MGD) water pumping capacity.
019	810 brake hp natural gas fired Caterpillar Model G3512 LE-130 engine for pump 4. Maximum heat input rate is 6.00 mmBtu/hr. Pump has a designed 20 MGD water pumping capacity.
020	2090 brake hp natural gas fired Caterpillar Model G3608 LE engine for pump 5. Maximum heat input rate is 13.70 mmBtu/hr. Pump has a designed 40 MGD water pumping capacity.

Note: These emissions units are not subject to any unit-specific applicable requirements. They are subject to the requirements of Section II, Facility-Wide Specific Conditions, of this permit. This permit was written to authorize removal of emissions units 003 through 005 and installation of these emissions units. The Waukesha units permitted in 1999 (0250314-003-AC) were not installed and are being replaced by the Caterpillar units. However, uncontrolled potential emissions are not significantly greater than past actual emissions for purposes of PSD. The Department is requiring initial tests for NOx emissions on both Unit No. 18 or 19 and Unit No. 20 for demonstration purposes only.

OPERATIONAL REQUIREMENTS

1. Hours of Operation: These emissions units may operate continuously, i.e., 8,760 hours/year. [Rule 62-210.200, F.A.C., Definitions-potential to emit (PTE)]

2. Fuel: The emission unit shall be fired with natural gas. Fuel consumption shall not exceed 88 million standard cubic feet (MMscf) in any consecutive 12-month period for Units 018 and 019 combined. Annual fuel consumption shall not exceed 111 MMscf in any consecutive 12-month period for Unit 020. The owner or operator shall keep monthly records of total fuel consumption for these emissions units. [Rule 62-210.200, F.A.C., Definitions-potential to emit (PTE)]

3. Operating Procedures: The emission unit shall be properly operated and maintained at all times in a condition to minimize emissions of air pollutants. The owner and operator shall ensure that all facility staff responsible for the emission unit is trained in the operation and maintenance in accordance with the guidelines and procedures as established by the equipment manufacturers. [Rule 62-4.070(3), F.A.C.]

4. Nitrogen Oxide (NOx) Initial Emission Tests: Initial NOx emissions tests shall be conducted on either Unit No. 18 or 19 and Unit No. 20. NOx emissions from Unit No. 18 or 19 shall not exceed 4.4 lb/hr. NOx emissions from Unit No. 20 shall not exceed 3.2 lb/hr. NOx emissions shall be demonstrated by using EPA Method 7 or 7E, as described in 40 CFR 60, Appendix A, adopted by reference in Rule 62-204.800, F.A.C., and adopted in Rule 62-297.401, F.A.C. Sampling of the exhaust gas shall be via a rake probe placed into the engine exhaust outlet. Test report shall be submitted to the Bureau of Air Regulation in Tallahassee. [Rule 62-210.200, F.A.C., Definitions-potential to emit (PTE)]

G.1 The terms, conditions, requirements, limitations, and restrictions set forth in this permit are "Permit Conditions" and are binding and enforceable pursuant to Sections 403.161, 403.727, or 403.859 through 403.861, Florida Statutes. The permittee is placed on notice that the Department will review this permit periodically and may initiate enforcement action for any violation of these conditions.

G.2 This permit is valid only for the specific processes and operations applied for and indicated in the approved drawings or exhibits. Any unauthorized deviation from the approved drawings or exhibits, specifications, or conditions of this permit may constitute grounds for revocation and enforcement action by the Department.

G.3 As provided in Subsections 403.087(6) and 403.722(5), Florida Statutes, the issuance of this permit does not convey and vested rights or any exclusive privileges. Neither does it authorize any injury to public or private property or any invasion of personal rights, nor any infringement of federal, state or local laws or regulations. This permit is not a waiver or approval of any other Department permit that may be required for other aspects of the total project which are not addressed in the permit.

G.4 This permit conveys no title to land or water, does not constitute State recognition or acknowledgment of title, and does not constitute authority for the use of submerged lands unless herein provided and the necessary title or leasehold interests have been obtained from the State. Only the Trustees of the Internal Improvement Trust Fund may express State opinion as to title.

G.5 This permit does not relieve the permittee from liability for harm or injury to human health or welfare, animal, or plant life, or property caused by the construction or operation of this permitted source, or from penalties therefore; nor does it allow the permittee to cause pollution in contravention of Florida Statutes and Department rules, unless specifically authorized by an order from the Department.

G.6 The permittee shall properly operate and maintain the facility and systems of treatment and control (and related appurtenances) that are installed or used by the permittee to achieve compliance with the conditions of this permit, as required by Department rules. This provision includes the operation of backup or auxiliary facilities or similar systems when necessary to achieve compliance with the conditions of the permit and when required by Department rules.

G.7 The permittee, by accepting this permit, specifically agrees to allow authorized Department personnel, upon presentation of credentials or other documents as may be required by law and at a reasonable time, access to the premises, where the permitted activity is located or conducted to:

(a) Have access to and copy and records that must be kept under the conditions of the permit;
(b) Inspect the facility, equipment, practices, or operations regulated or required under this permit, and,
(c) Sample or monitor any substances or parameters at any location reasonably necessary to assure compliance with this permit or Department rules.

Reasonable time may depend on the nature of the concern being investigated.

G.8 If, for any reason, the permittee does not comply with or will be unable to comply with any condition or limitation specified in this permit, the permittee shall immediately provide the Department with the following information:

(a) A description of and cause of non-compliance; and
(b) The period of noncompliance, including dates and times; or, if not corrected, the anticipated time the non-compliance is expected to continue, and steps being taken to reduce, eliminate, and prevent recurrence of the non-compliance.

The permittee shall be responsible for any and all damages which may result and may be subject to enforcement action by the Department for penalties or for revocation of this permit.

G.9 In accepting this permit, the permittee understands and agrees that all records, notes, monitoring data and other information relating to the construction or operation of this permitted source which are submitted to the Department may be used by the Department as evidence in any enforcement case involving the permitted source arising under the Florida Statutes or Department rules, except where such use is prescribed by Sections 403.73 and 403.111, Florida Statutes. Such evidence shall only be used to the extend it is consistent with the Florida Rules of Civil Procedure and appropriate evidentiary rules.

G.10 The permittee agrees to comply with changes in Department rules and Florida Statutes after a reasonable time for compliance, provided, however, the permittee does not waive any other rights granted by Florida Statutes or Department rules.

G.11 This permit is transferable only upon Department approval in accordance with Florida Administrative Code Rules 62-4.120 and 62-730.300, F.A.C., as applicable. The permittee shall be liable for any non-compliance of the permitted activity until the transfer is approved by the Department.

G.12 This permit or a copy thereof shall be kept at the work site of the permitted activity.

G.13 This permit also constitutes:

(a) Determination of Best Available Control Technology ( );
(b) Determination of Prevention of Significant Deterioration ( ); and
(c) Compliance with New Source Performance Standards ( ).

G.14 The permittee shall comply with the following:

(a) Upon request, the permittee shall furnish all records and plans required under Department rules. During enforcement actions, the retention period for all records will be extended automatically unless otherwise stipulated by the Department.
(b) The permittee shall hold at the facility or other location designated by this permit records of all monitoring information (including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation) required by the permit, copies of all reports required by this permit, and records of all data used to complete the application or this permit. These materials shall be retained at least three years from the date of the sample, measurement, report, or application unless otherwise specified by Department rule.
(c) Records of monitoring information shall include:

1. The date, exact place, and time of sampling or measurements;
2. The person responsible for performing the sampling or measurements;
3. The dates analyses were performed;
4. The person responsible for performing the analyses;
5. The analytical techniques or methods used; and
6. The results of such analyses.

G.15 When requested by the Department, the permittee shall within a reasonable time furnish any information required by law which is needed to determine compliance with the permit. If the permittee becomes aware that relevant facts were not submitted or were incorrect in the permit application or in any report to the Department, such facts or information shall be corrected promptly.

SENDER: *COMPLETE THIS SECTION*

- Complete items 1, 2, and 3. Also complete item 4 if Restricted Delivery is desired.
- Print your name and address on the reverse so that we can return the card to you.
- Attach this card to the back of the mailpiece, or on the front if space permits.

1. Article Addressed to:

Jorge S. Rodriguez, P.E.
Assistant Director - Water
Miami-Dade Water & Sewer Department
3071 SW 38th Avenue
Miami, FL 33146-1520

COMPLETE THIS SECTION ON DELIVERY

A. Received by *(Please Print Clearly)* | B. Date of Delivery 11/4/02

C. Signature

X [signature] ☐ Agent ☐ Addressee

D. Is delivery address different from item 1? ☐ Yes
If YES, enter delivery address below: ☐ No

3. Service Type
☑ Certified Mail ☐ Express Mail
☐ Registered ☐ Return Receipt for Merchandise
☐ Insured Mail ☐ C.O.D.

4. Restricted Delivery? *(Extra Fee)* ☐ Yes

2. 7001 0320 0001 3692 7720

PS Form 3811, July 1999 Domestic Return Receipt 102595-00-M-0952

U.S. Postal Service
CERTIFIED MAIL RECEIPT
(Domestic Mail Only; No Insurance Coverage Provided)

OFFICIAL USE

Postage	$
Certified Fee	
Return Receipt Fee (Endorsement Required)	
Restricted Delivery Fee (Endorsement Required)	
Total Postage & Fees	$

Postmark Here

Sent To: Jorge S. Rodriguez
Street, Apt. No., or PO Box No. 3071 SW 38th Ave.
City, State, ZIP+4 Miami, FL 33146-1520

7001 0320 0001 3692 7720

PS Form 3800, January 2001 See Reverse for Instructions

SERVE • CONSERVE

MIAMI-DADE WATER AND SEWER DEPARTMENT
P.O. Box 330316, Miami, Florida 33233-0316 • 3575 S. LeJeune Road • Tel: 305-665-7471

October 31, 2002

Certified Mail: 7001 0360 0001 6782 8001
Return Receipt

Mr. Syed Arif, P.E.
New Source Review Section
Florida Department of Environmental Protection
2600 Blair Stone Road
Tallahassee, FL 32399-2400

Re: Draft Air Construction Permit Comments, Alexander Orr, Jr. Water Treatment Plant, Three Natural Gas Fueled Engine Driven Pump Sets and One Diesel Fueled Standby Generator, DEP File No. 0250314-005-AC

Dear Mr. Arif:

Attached, please find a file copy of the letter that was transmitted via e-mail on October 15, 2002; original sent via regular post on October 18, 2002.

Please contact me at (786) 552-8123 if there are any questions.

Sincerely,

Richard M. O'Rourke, P.E.
Permitting

RMO/ro

cc: Gracy Danois, EPA Region 4
Tom Tittle, FDEP/SED
Mallika Muthiah, M-D/DERM

Attachment: Miami-Dade Water & Sewer Letter Dated October 15, 2002

L0257dep.doc

MIAMI-DADE WATER AND SEWER DEPARTMENT
P.O. Box 330316, Miami, Florida 33233-0316 • 3575 S. LeJeune Road • Tel: 305-665-7471

SERVE • CONSERVE

October 15, 2002

ELECTRONIC CORRESPONDENCE
SYED.ARIF@DEP.STATE.FL.US

Mr. Syed Arif, P.E.
New Source Review Section
Florida Department of Environmental Protection
2600 Blair Stone Road
Tallahassee, FL 32399-2400

Re: Draft Air Construction Permit Comments, Alexander Orr, Jr. Water Treatment Plant, Three Natural Gas Fueled Engine Driven Pump Sets and One Diesel Fueled Standby Generator, DEP File No. 0250314-005-AC

Dear Mr. Arif:

The Miami-Dade Water and Sewer Department (MDWASD) received the referenced draft air construction permit issued by the Florida Department of Environmental Protection (FDEP) on October 2, 2002.

The following comments pertain to the Specific Conditions for the Caterpillar Model 3508 TA-130 emergency generator in Section III of the DRAFT Permit:

1. Hours of Operation: WASD requests that this condition be changed to read: "1. Hours of Operation: The hours of operation for this emission unit shall not exceed 500 hours in any consecutive 12-month period."

2. Fuel: WASD requests that the last two sentences regarding fuel consumption be removed and the condition be revised to read: "2. Fuel: The emission unit shall be fired with diesel fuel with a maximum sulfur content of 0.05 percent, by weight. {Permitting note: At 100% engine load a Model 3508 engine fuel consumption is 66.5 gallons per hour, based on a 35-degree API diesel fuel with a higher heating value of 18,390 Btu/lb. On this basis, the fuel consumption for 500 hours of operation at 100 percent engine load is approximately 33,250 gallons.}"

9. Fuel Consumption: WASD requests that this condition be changed to: "9. Hours of Operation: The owner or operator shall monitor the hours of operation of the emission units with an hour meter."

10. Meter Fuel Calibration: WASD recommends that this condition be removed in its entirety.

These changes are requested because the emissions of nitrous oxides, the pollutant of concern, in the permit application was based on an hourly emission rate for 500 hours of operation at full load and not on an emission factor for fuel consumption.

As the designated Responsible Official of this facility, I certify this to be true, accurate, and complete based upon information and belief formed after reasonable inquiry. Please contact me at (786) 552-8112 or Mr. Richard M. O'Rourke, P.E. at (786) 552-8123 if there are any questions regarding this letter.

Sincerely,

Jorge S. Rodriguez, P.E.
Assistant Director - Water

JSR/RMO/ro

c: Gracy Danois, EPA Region 4
Tom Tittle, FDEP/SED
Mallika Muthiah, M-D/DERM

bc: W. Brant
J. Rodriguez
H. Codispoti
T. Segars
M. Berounsky
J. Epaves
B. Goldenberg
D. Edwards

SERVE • CONSERVE

MIAMI-DADE WATER AND SEWER DEPARTMENT
P.O. Box 330316, Miami, Florida 33233-0316 • 3575 S. LeJeune Road • Tel: 305-665-7471

October 4, 2002

Certified Mail: 7001 0360 0001 6782 7950
Return Receipt

Mr. Syed Arif, P.E.
New Source Review Section
Florida Department of Environmental Protection
2600 Blair Stone Road
Tallahassee, FL 32399-2400

Re: Alexander Orr, Jr. Water Treatment Plant, Three Natural Gas Fueled Engine Driven Pump Sets and One Diesel Fueled Standby Generator, DEP File No. 0250314-005-AC

Dear Mr. Arif:

Attached, please find the certified proofs of publication for the "Public Notice of Intent to Issue Air Construction Permit" for the subject Title V Air Construction Permit Application.

Should there be any questions regarding this submission, please contact me at (786) 552-8123.

Sincerely,

Richard M. O'Rourke, P.E.
Environmental Permits

RMO/ro

c: Tom Tittle, DEP Southeast District
Patrick Wong, Dade County DERM
Gregg Worley, EPA Region 4
Charlie Neese, Poole & Kent

Attachment: Notarized Proof of Publication of Public Notice of Intent to Issue Air Construction Permit, DEP File No. 0250314-005-AC (Two Pages)

L0251dep.doc

MIAMI DAILY BUSINESS REVIEW

Published Daily except Saturday, Sunday and
Legal Holidays
Miami, Miami-Dade County, Florida

STATE OF FLORIDA
COUNTY OF MIAMI-DADE:

Before the undersigned authority personally appeared O.V. FERBEYRE, who on oath says that he or she is the SUPERVISOR, Legal Notices of the Miami Daily Business Review f/k/a Miami Review, a daily (except Saturday, Sunday and Legal Holidays) newspaper, published at Miami in Miami-Dade County, Florida; that the attached copy of advertisement, being a Legal Advertisement of Notice in the matter of

NOTICE OF INTENT TO ISSUE AIR CONSTRUCTION PERMIT TO MIAMI-DADE WATER & SEWER DEPT.

in the XXXX Court,
was published in said newspaper in the issues of

10/02/2002

Affiant further says that the said Miami Daily Business Review is a newspaper published at Miami in said Miami-Dade County, Florida and that the said newspaper has heretofore been continuously published in said Miami-Dade County, Florida, each day (except Saturday, Sunday and Legal Holidays) and has been entered as second class mail matter at the post office in Miami in said Miami-Dade County, Florida, for a period of one year next preceding the first publication of the attached copy of advertisement; and affiant further says that he or she has neither paid nor promised any person, firm or corporation any discount, rebate, commission or refund for the purpose of securing this advertisement for publication in the said newspaper.

Sworn to and subscribed before me this

02 day of OCTOBER , A.D. 2002

(SEAL)

O.V. FERBEYRE personally known to me

MARIA I. MESA
MY COMMISSION # CC 885640
EXPIRES: March 4, 2004
Bonded Thru Notary Public Underwriters

PUBLIC NOTICE OF INTENT TO ISSUE AIR CONSTRUCTION PERMIT

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

DEP File No. 0250314-005-AC

Miami-Dade Water & Sewer Department
Alexander Orr, Jr. Water Treatment Plant
Miami-Dade County

The Department of Environmental Protection (Department) gives notice of its intent to issue an air construction permit to Miami-Dade Water & Sewer Department, for the Alexander Orr, Jr. Water Treatment Plant located at 6800 SW 87 Avenue, Miami, Miami-Dade County. The permit is to remove existing pumps and engines numbers 1 and 2, replacing the (pump/generator) capacity of engine number 1 with a diesel fueled engine driven emergency generator set and to replace existing diesel fueled engine driven pump numbers 3, 4 and 5 with three natural gas fueled engine driven pumps. The applicant's mailing address is: 3071 SW 38th Avenue, Miami, Florida 33146-1520. A Best Available Control Technology (BACT) determination was not required pursuant to Rule 62-212.400, F.A.C. and 40 CFR 52.21, Prevention of Significant Deterioration (PSD).

The existing pump engines are fuel oil fired. The replacement engines have significantly lower air pollutant emissions per unit of work. The replacement emergency generator is restricted to 500 hours of operation annually. This restriction will keep nitrogen oxides emissions below the PSD significance levels. With the exception of carbon monoxide, potential emissions from the new engines are not expected to significantly increase compared to the past actual emissions of the existing engines. Carbon monoxide emissions do not increase above the PSD significance levels. An air quality impact analysis was not required or conducted.

The original permitting was done in 1999. The units proposed in the previous permit were not installed, the emission increment was not consumed and this project replaces the previous one.

The Department will issue the Final permit modification with the attached conditions unless a response received in accordance with the following procedures results in a different decision or significant change of terms or conditions.

The Department will accept written comments concerning the proposed permit modification issuance action for a period of 14 (fourteen) days from the date of publication of this Public Notice of Intent to Issue PSD permit modification. Written comments should be provided to the Department's Bureau of Air Regulation at 2600 Blair Stone Road, Mail Station #5505, Tallahassee, FL 32399-2400. Any written comments filed shall be made available for public inspection. If written comments received result in a significant change in the proposed agency action, the Department shall revise the proposed permit modification and require, if applicable, another Public Notice.

The Department will issue the permit modification with the attached conditions unless a timely petition for an administrative hearing is filed pursuant to sections 120.569 and 120.57 F.S., before the deadline for filing a petition. The procedures for petitioning for a hearing are set forth below. Mediation is not available in this proceeding.

A person whose substantial interests are affected by the proposed permitting decision may petition for an administrative proceeding (hearing) under sections 120.569 and 120.57 of the Florida Statutes. The petition must contain the information set forth below and must be filed (received) in the Office of General Counsel of the Department at 3900 Commonwealth Boulevard, Mail Station #35, Tallahassee, Florida, 32399-3000. Petitions filed by the permit applicant or any of the parties listed below must be filed within fourteen days of receipt of this notice of intent. Petitions filed by any persons other than those entitled to written notice under section 120.60(3) of the Florida Statutes must be filed within fourteen days of publication of the public notice or within fourteen days of receipt of this notice of intent, whichever occurs first. Under section 120.60(3), however, any person who asked the Department for notice of agency action may file a petition within fourteen days of receipt of that notice, regardless of the date of publication. A petitioner shall mail a copy of the petition to the applicant at the address indicated above at the time of filing. The failure of any person to file a petition within the appropriate time period shall constitute a waiver of that person's right to request an administrative determination (hearing) under sections 120.569 and 120.57 F.S., or to intervene in this proceeding and participate as a party to it. Any subsequent intervention will be only at the approval of the presiding officer upon the filing of a motion in compliance with Rule 28-106.205 of the Florida Administrative Code.

A petition that disputes the material facts on which the Department's action is based must contain the following information: (a) The name and address of each agency affected and each agency's file or identification number, if known; (b) The name, address, and telephone number of the petitioner, the name, address, and telephone number of the petitioner's representative, if any, which shall be the address for service purposes during the course of the proceeding; and an explanation of how the petitioner's substantial interests will be affected by the agency determination; (c) A statement of how and when petitioner received notice of the agency action or proposed action; (d) A statement of all disputed issues of material fact. If there are none, the petition must so indicate; (e) A concise statement of the ultimate facts alleged, including the specific facts the petitioner contends warrant reversal or modification of the agency's proposed action; (f) A statement of the specific rules or statutes the petitioner contends require reversal or modification of the agency's proposed action; and (g) A statement of the relief sought by the petitioner, stating precisely the action petitioner wishes the agency to take with respect to the agency's proposed action.

A petition that does not dispute the material facts upon which the Department's action is based shall state that no such facts are in dispute and otherwise shall contain the same information as set forth above, as required by Rule 28-106.301

Because the administrative hearing process is designed to formulate final agency action, the filing of a petition means that the Department's final action may be different from the position taken by it in this notice. Persons whose substantial interests will be affected by any such final decision of the Department on the application have the right to petition to become a party to the proceeding, in accordance with the requirements set forth above.

A complete project file is available for public inspection during normal business hours, 8:00 a.m. to 5:00 p.m., Monday through Friday, except legal holidays, at:

Dept. of Environmental Protection
Bureau of Air Regulation
Suite 4, 111 S. Magnolia Drive
Tallahassee, Florida 32301
Telephone: 850/488-0114
Fax: 850/922-6979

Dept. of Environmental Protection
Southeast District
400 North Congress Avenue
West Palm Beach, Florida 33401
Telephone: 561/681-6600

Dade County Department of
Environmental Resources Mgmt.
Suite 900, 33 Southwest 2nd Ave.
Miami, Florida 33130-1540
Telephone: 305/372-6925

The complete project file includes the application, technical evaluations, Draft permit, and the information submitted by the responsible official, exclusive of confidential records under Section 403.111, F.S. Interested persons may contact the Administrator, New Source Review Section, or the Department's reviewing engineer for this project, Syed Arif, P.E., at 111 South Magnolia Drive, Suite 4, Tallahassee, Florida 32301, or call 850/488-0114, for additional information.

10/2 02-4-09/302121M

Department of Environmental Protection

Jeb Bush
Governor

Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

David B. Struhs
Secretary

September 25, 2002

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

Mr. Jorge S. Rodriguez, P.E.
Assistant Director – Water
Miami-Dade Water & Sewer Department
3071 SW 38th Avenue
Miami, Florida 33146-1520

Re: DEP File No. 0250314-005-AC
Alexander Orr, Jr. WTP
Three Natural Gas Fueled Engine Driven Pump Sets and One Diesel Fueled Standby Generator

Dear Mr. Rodriguez:

Enclosed is one copy of the Draft air construction permit for the Alexander Orr, Jr. WTP, Three Natural Gas Fueled Engine Driven Pump Sets and One Diesel Fueled Standby Generator, located at 6800 SW 87 Avenue, Miami, Miami-Dade County. The Technical Evaluation and Preliminary Determination, the Department's Intent to Issue Air Construction Permit and the Public Notice of Intent to Issue Air Construction Permit are also included.

The Public Notice of Intent to Issue Air Construction Permit must be published one time only, as soon as possible, in the legal advertisement section of a newspaper of general circulation in the area affected, pursuant to the requirements Chapter 50, Florida Statutes. Proof of publication, i.e., newspaper affidavit, must be provided to the Department's Bureau of Air Regulation office within seven days of publication. Failure to publish the notice and provide proof of publication may result in the denial of the permit.

Please submit any written comments you wish to have considered concerning the Department's proposed action to me at the above letterhead address. If you have any other questions, please contact Syed Arif, P.E. at 850/921-9528.

Sincerely,

A. A. Linero, P.E.
Bureau of Air Regulation

AAL/sa

Enclosures

SENDER: *COMPLETE THIS SECTION*

- Complete items 1, 2, and 3. Also complete item 4 if Restricted Delivery is desired.
- Print your name and address on the reverse so that we can return the card to you.
- Attach this card to the back of the mailpiece, or on the front if space permits.

1. Article Addressed to:

Jorge S. Rodriguez, P.E.
Assistant Director - Water
Miami-Dade Water & Sewer Department
3071 SW 38th Avenue
Miami, FL 33146-1520

COMPLETE THIS SECTION ON DELIVERY

A. Received by *(Please Print Clearly)* S. MARTINEZ — B. Date of Delivery 10/2/02

C. Signature — ☐ Agent ☐ Addressee

D. Is delivery address different from item 1? ☐ Yes
If YES, enter delivery address below: ☐ No

3. Service Type
☑ Certified Mail ☐ Express Mail
☐ Registered ☐ Return Receipt for Merchandise
☐ Insured Mail ☐ C.O.D.

4. Restricted Delivery? *(Extra Fee)* ☐ Yes

2. 7001 0320 0001 3692 7911

PS Form 3811, July 1999 — Domestic Return Receipt — 102595-00-M-0952

U.S. Postal Service
CERTIFIED MAIL RECEIPT
(Domestic Mail Only; No Insurance Coverage Provided)

OFFICIAL USE

Postage	$
Certified Fee	
Return Receipt Fee (Endorsement Required)	
Restricted Delivery Fee (Endorsement Required)	
Total Postage & Fees	$

Postmark Here

7001 0320 0001 3692 7911

Sent To: Jorge S. Rodriguez
Street, Apt. No.; or PO Box No.: 3071 SW 38th Ave.
City, State, ZIP+4: Miami, FL 33146-1520

PS Form 3800, January 2001 — See Reverse for Instructions

In the Matter of an
Application for Permit by:

Mr. Jorge S. Rodriguez, P.E.,
Assistant Director – Water
Miami-Dade Water & Sewer Department
3071 SW 38th Avenue
Miami, Florida 33146-1520

DEP File No. 0250314-005-AC

Alexander Orr, Jr. WTP
Natural Gas Fueled Engine Driven Pump Sets
Miami-Dade County

INTENT TO ISSUE AIR CONSTRUCTION PERMIT

The Department of Environmental Protection (Department) gives notice of its intent to issue an air construction permit (copy of Draft permit attached) for the proposed project, detailed in the application specified above and the enclosed Technical Evaluation and Preliminary Determination, for the reasons stated below.

The applicant, Miami-Dade Water & Sewer Department, applied on May 13, 2002, to the Department for an air construction permit for its Alexander Orr, Jr. Water Treatment Plant located at 6800 SW 87 Avenue, Miami, Miami-Dade County. The permit is for the replacement of five diesel fueled engine driven pump sets with three natural gas fueled engine driven pump sets and one diesel fueled standby generator.

The Department has permitting jurisdiction under the provisions of Chapter 403, Florida Statutes (F.S.), and Florida Administrative Code (F.A.C.) Chapters 62-4, 62-210, and 62-212. The above actions are not exempt from permitting procedures. The Department has determined that a construction permit modification is required.

The Department intends to issue this air construction permit based on the belief that reasonable assurances have been provided to indicate that operation of these emission units will not adversely impact air quality, and the emission units will comply with all appropriate provisions of Chapters 62-4, 62-204, 62-210, 62-212, 62-296, and 62-297, F.A.C.

Pursuant to Section 403.815, F.S., and Rule 62-110.106(7)(a)1., F.A.C., you (the applicant) are required to publish at your own expense the enclosed Public Notice of Intent to Issue Air Construction Permit. The notice shall be published one time only in the legal advertisement section of a newspaper of general circulation in the area affected. Rule 62-110.106(7)(b), F.A.C., requires that the applicant cause the notice to be published as soon as possible after notification by the Department of its intended action. For the purpose of these rules, "publication in a newspaper of general circulation in the area affected" means publication in a newspaper meeting the requirements of Sections 50.011 and 50.031, F.S., in the county where the activity is to take place. If you are uncertain that a newspaper meets these requirements, please contact the Department at the address or telephone number listed below. The applicant shall provide proof of publication to the Department's Bureau of Air Regulation, at 2600 Blair Stone Road, Mail Station #5505, Tallahassee, Florida 32399-2400 (Telephone: 850/488-0114; Fax 850/ 922-6979). You must provide proof of publication within seven days of publication, pursuant to Rule 62-110.106(5), F.A.C. No permitting action for which published notice is required shall be granted until proof of publication of notice is made by furnishing a uniform affidavit in substantially the form prescribed in section 50.051, F.S. to the office of the Department issuing the permit. Failure to publish the notice and provide proof of publication may result in the denial of the permit pursuant to Rules 62-110.106(9) & (11), F.A.C.

The Department will issue the final permit with the attached conditions unless a response received in accordance with the following procedures results in a different decision or significant change of terms or conditions.

The Department will accept written comments concerning the proposed permit issuance action for a period of 14 (fourteen) days from the date of publication of Public Notice of Intent to Issue Air Permit. Written comments should be provided to the Department's Bureau of Air Regulation at 2600 Blair Stone Road, Mail Station #5505, Tallahassee, FL 32399-2400. Any written comments filed shall be made available for public inspection. If written comments received result in a significant change in the proposed agency action, the Department shall revise the proposed permit and require, if applicable, another Public Notice.

The Department will issue the permit with the attached conditions unless a timely petition for an administrative hearing is filed pursuant to sections 120.569 and 120.57 F.S., before the deadline for filing a petition. The procedures for petitioning for a hearing are set forth below.

A person whose substantial interests are affected by the proposed permitting decision may petition for an administrative proceeding (hearing) under sections 120.569 and 120.57 of the Florida Statutes. The petition must contain the information set forth below and must be filed (received) in the Office of General Counsel of the Department at 3900 Commonwealth Boulevard, Mail Station #35, Tallahassee, Florida, 32399-3000. Petitions filed by the permit applicant or any of the parties listed below must be filed within fourteen days of receipt of this notice of intent. Petitions filed by any persons other than those entitled to written notice under section 120.60(3) of the Florida Statutes must be filed within fourteen days of publication of the public notice or within fourteen days of receipt of this notice of intent, whichever occurs first. Under section 120.60(3), however, any person who asked the Department for notice of agency action may file a petition within fourteen days of receipt of that notice, regardless of the date of publication. A petitioner shall mail a copy of the petition to the applicant at the address indicated above at the time of filing. The failure of any person to file a petition within the appropriate time period shall constitute a waiver of that person's right to request an administrative determination (hearing) under sections 120.569 and 120.57 F.S., or to intervene in this proceeding and participate as a party to it. Any subsequent intervention will be only at the approval of the presiding officer upon the filing of a motion in compliance with Rule 28-106.205 of the Florida Administrative Code.

A petition that disputes the material facts on which the Department's action is based must contain the following information: (a) The name and address of each agency affected and each agency's file or identification number, if known; (b) The name, address, and telephone number of the petitioner, the name, address, and telephone number of the petitioner's representative, if any, which shall be the address for service purposes during the course of the proceeding; and an explanation of how the petitioner's substantial interests will be affected by the agency determination; (c) A statement of how and when petitioner received notice of the agency action or proposed action; (d) A statement of all disputed issues of material fact. If there are none, the petition must so indicate; (e) A concise statement of the ultimate facts alleged, including the specific facts the petitioner contends warrant reversal or modification of the agency's proposed action; (f) A statement of the specific rules or statutes the petitioner contends require reversal or modification of the agency's proposed action; and (g) A statement of the relief sought by the petitioner, stating precisely the action petitioner wishes the agency to take with respect to the agency's proposed action.

A petition that does not dispute the material facts upon which the Department's action is based shall state that no such facts are in dispute and otherwise shall contain the same information as set forth above, as required by Rule 28-106.301.

Because the administrative hearing process is designed to formulate final agency action, the filing of a petition means that the Department's final action may be different from the position taken by it in this notice. Persons whose substantial interests will be affected by any such final decision of the Department on the application have the right to petition to become a party to the proceeding, in accordance with the requirements set forth above.

Mediation is not available in this proceeding.

In addition to the above, a person subject to regulation has a right to apply for a variance from or waiver of the requirements of particular rules, on certain conditions, under Section 120.542 F.S. The relief provided by this state statute applies only to state rules, not statutes, and not to any federal regulatory requirements. Applying for a variance or waiver does not substitute or extend the time for filing a petition for an administrative hearing or exercising any other right that a person may have in relation to the action proposed in this notice of intent.

The application for a variance or waiver is made by filing a petition with the Office of General Counsel of the Department, 3900 Commonwealth Boulevard, Mail Station #35, Tallahassee, Florida 32399-3000. The petition must specify the following information: (a) The name, address, and telephone number of the petitioner; (b) The name, address, and telephone number of the attorney or qualified representative of the petitioner, if any; (c) Each rule or portion of a rule from which a variance or waiver is requested; (d) The citation to the statute underlying (implemented by) the rule identified in (c) above; (e) The type of action requested; (f) The specific facts that would justify a variance or waiver for the petitioner; (g) The reason why the variance or waiver would serve the purposes

of the underlying statute (implemented by the rule); and (h) A statement whether the variance or waiver is permanent or temporary and, if temporary, a statement of the dates showing the duration of the variance or waiver requested.

The Department will grant a variance or waiver when the petition demonstrates both that the application of the rule would create a substantial hardship or violate principles of fairness, as each of those terms is defined in Section 120.542(2) F.S., and that the purpose of the underlying statute will be or has been achieved by other means by the petitioner.

Persons subject to regulation pursuant to any federally delegated or approved air program should be aware that Florida is specifically not authorized to issue variances or waivers from any requirements of any such federally delegated or approved program. The requirements of the program remain fully enforceable by the Administrator of the EPA and by any person under the Clean Air Act unless and until the Administrator separately approves any variance or waiver in accordance with the procedures of the federal program.

Executed in Tallahassee, Florida.

A. A. Linero, P.E.
Bureau of Air Regulation

CERTIFICATE OF SERVICE

The undersigned duly designated deputy agency clerk hereby certifies that this Intent to Issue Air Construction Permit Modification (including the Public Notice of Intent to Issue Air Construction Permit Modification, and the Draft permit) was sent by certified mail (*) and copies were mailed by U.S. Mail before the close of business on 9/30/02 to the person(s) listed:

Mr. Jorge S. Rodriguez, P.E., Miami-Dade WASD*
Mr. Richard O'Rourke, P.E., WASD (via e-mail)
Mr. Tom Tittle, DEP, SED
Mr. Patrick Wong, DERM

Clerk Stamp

FILING AND ACKNOWLEDGMENT FILED, on this date, pursuant to §120.52, Florida Statutes, with the designated Department Clerk, receipt of which is hereby acknowledged.

Victoria Gibson (Clerk) September 30, 2002 (Date)

PUBLIC NOTICE OF INTENT TO ISSUE AIR CONSTRUCTION PERMIT

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

DEP File No. 0250314-005-AC

Miami-Dade Water & Sewer Department
Alexander Orr, Jr. Water Treatment Plant
Miami-Dade County

The Department of Environmental Protection (Department) gives notice of its intent to issue an air construction permit to Miami-Dade Water & Sewer Department, for the Alexander Orr, Jr. Water Treatment Plant located at 6800 SW 87 Avenue, Miami, Miami-Dade County. The permit is to remove existing pumps and engines numbers 1 and 2, replacing the (pump/generator) capacity of engine number 1 with a diesel fueled engine driven emergency generator set and to replace existing diesel fueled engine driven pump numbers 3, 4 and 5 with three natural gas fueled engine driven pumps. The applicant's mailing address is: 3071 SW 38th Avenue, Miami, Florida 33146-1520. A Best Available Control Technology (BACT) determination was not required pursuant to Rule 62-212.400, F.A.C. and 40 CFR 52.21, Prevention of Significant Deterioration (PSD).

The existing pump engines are fuel oil fired. The replacement engines have significantly lower air pollutant emissions per unit of work. The replacement emergency generator is restricted to 500 hours of operation annually. This restriction will keep nitrogen oxides emissions below the PSD significance levels. With the exception of carbon monoxide, potential emissions from the new engines are not expected to significantly increase compared to the past actual emissions of the existing engines. Carbon monoxide emissions do not increase above the PSD significance levels. An air quality impact analysis was not required or conducted.

The original permitting was done in 1999. The units proposed in the previous permit were not installed, the emission increment was not consumed and this project replaces the previous one.

The Department will issue the Final permit modification with the attached conditions unless a response received in accordance with the following procedures results in a different decision or significant change of terms or conditions.

The Department will accept written comments concerning the proposed permit modification issuance action for a period of 14 (fourteen) days from the date of publication of this Public Notice of Intent to Issue PSD permit modification. Written comments should be provided to the Department's Bureau of Air Regulation at 2600 Blair Stone Road, Mail Station #5505, Tallahassee, FL 32399-2400. Any written comments filed shall be made available for public inspection. If written comments received result in a significant change in the proposed agency action, the Department shall revise the proposed permit modification and require, if applicable, another Public Notice.

The Department will issue the permit modification with the attached conditions unless a timely petition for an administrative hearing is filed pursuant to sections 120.569 and 120.57 F.S., before the deadline for filing a petition. The procedures for petitioning for a hearing are set forth below. Mediation is not available in this proceeding.

A person whose substantial interests are affected by the proposed permitting decision may petition for an administrative proceeding (hearing) under sections 120.569 and 120.57 of the Florida Statutes. The petition must contain the information set forth below and must be filed (received) in the Office of General Counsel of the Department at 3900 Commonwealth Boulevard, Mail Station #35, Tallahassee, Florida, 32399-3000. Petitions filed by the permit applicant or any of the parties listed below must be filed within fourteen days of receipt of this notice of intent. Petitions filed by any persons other than those entitled to written notice under section 120.60(3) of the Florida Statutes must be filed within fourteen days of publication of the public notice or within fourteen days of receipt of this notice of intent, whichever occurs first. Under section 120.60(3), however, any person who asked the Department for notice of agency action may file a petition within fourteen days of receipt of that notice, regardless of the date of publication. A petitioner shall mail a copy of the petition to the applicant at the address indicated above at the time of filing. The failure of any person to file a petition within the appropriate time period shall constitute a waiver of that person's right to request an administrative determination (hearing) under sections 120.569 and 120.57 F.S., or to intervene in this proceeding and participate as a party to it. Any subsequent intervention will be only at

NOTICE TO BE PUBLISHED IN THE NEWSPAPER

the approval of the presiding officer upon the filing of a motion in compliance with Rule 28-106.205 of the Florida Administrative Code.

A petition that disputes the material facts on which the Department's action is based must contain the following information: (a) The name and address of each agency affected and each agency's file or identification number, if known; (b) The name, address, and telephone number of the petitioner, the name, address, and telephone number of the petitioner's representative, if any, which shall be the address for service purposes during the course of the proceeding; and an explanation of how the petitioner's substantial interests will be affected by the agency determination; (c) A statement of how and when petitioner received notice of the agency action or proposed action; (d) A statement of all disputed issues of material fact. If there are none, the petition must so indicate; (e) A concise statement of the ultimate facts alleged, including the specific facts the petitioner contends warrant reversal or modification of the agency's proposed action; (f) A statement of the specific rules or statutes the petitioner contends require reversal or modification of the agency's proposed action; and (g) A statement of the relief sought by the petitioner, stating precisely the action petitioner wishes the agency to take with respect to the agency's proposed action.

A petition that does not dispute the material facts upon which the Department's action is based shall state that no such facts are in dispute and otherwise shall contain the same information as set forth above, as required by Rule 28-106.301

Because the administrative hearing process is designed to formulate final agency action, the filing of a petition means that the Department's final action may be different from the position taken by it in this notice. Persons whose substantial interests will be affected by any such final decision of the Department on the application have the right to petition to become a party to the proceeding, in accordance with the requirements set forth above.

A complete project file is available for public inspection during normal business hours, 8:00 a.m. to 5:00 p.m., Monday through Friday, except legal holidays, at:

Dept. of Environmental Protection
Bureau of Air Regulation
Suite 4, 111 S. Magnolia Drive
Tallahassee, Florida 32301
Telephone: 850/488-0114
Fax: 850/922-6979

Dept. of Environmental Protection
Southeast District
400 North Congress Avenue
West Palm Beach, Florida 33401
Telephone: 561/681-6600

Dade County Department of
Environmental Resources Mgmt.
Suite 900, 33 Southwest 2nd Ave.
Miami, Florida 33130-1540
Telephone: 305/372-6925

The complete project file includes the application, technical evaluations, Draft permit, and the information submitted by the responsible official, exclusive of confidential records under Section 403.111, F.S. Interested persons may contact the Administrator, New Source Review Section, or the Department's reviewing engineer for this project, Syed Arif, P.E., at 111 South Magnolia Drive, Suite 4, Tallahassee, Florida 32301, or call 850/488-0114, for additional information.

NOTICE TO BE PUBLISHED IN THE NEWSPAPER

TECHNICAL EVALUATION

AND

PRELIMINARY DETERMINATION

Miami-Dade Water & Sewer Department

Alexander Orr, Jr. WTP

Three Natural Gas Fueled Engine Driven Pump Sets & One Diesel Fueled Standby Generator

Miami-Dade County

DEP File No. 0250314-005-AC

Department of Environmental Protection
Division of Air Resources Management
Bureau of Air Regulation

September 25, 2002

TECHNICAL EVALUATION AND PRELIMINARY DETERMINATION

1. GENERAL INFORMATION

1.1 APPLICANT NAME AND ADDRESS

Miami-Dade Water & Sewer Department
3071 SW 38th Avenue
Miami, Florida 33146-1520

Authorized Representative: Mr. Jorge S. Rodriguez, P.E., Assistant Director - Water

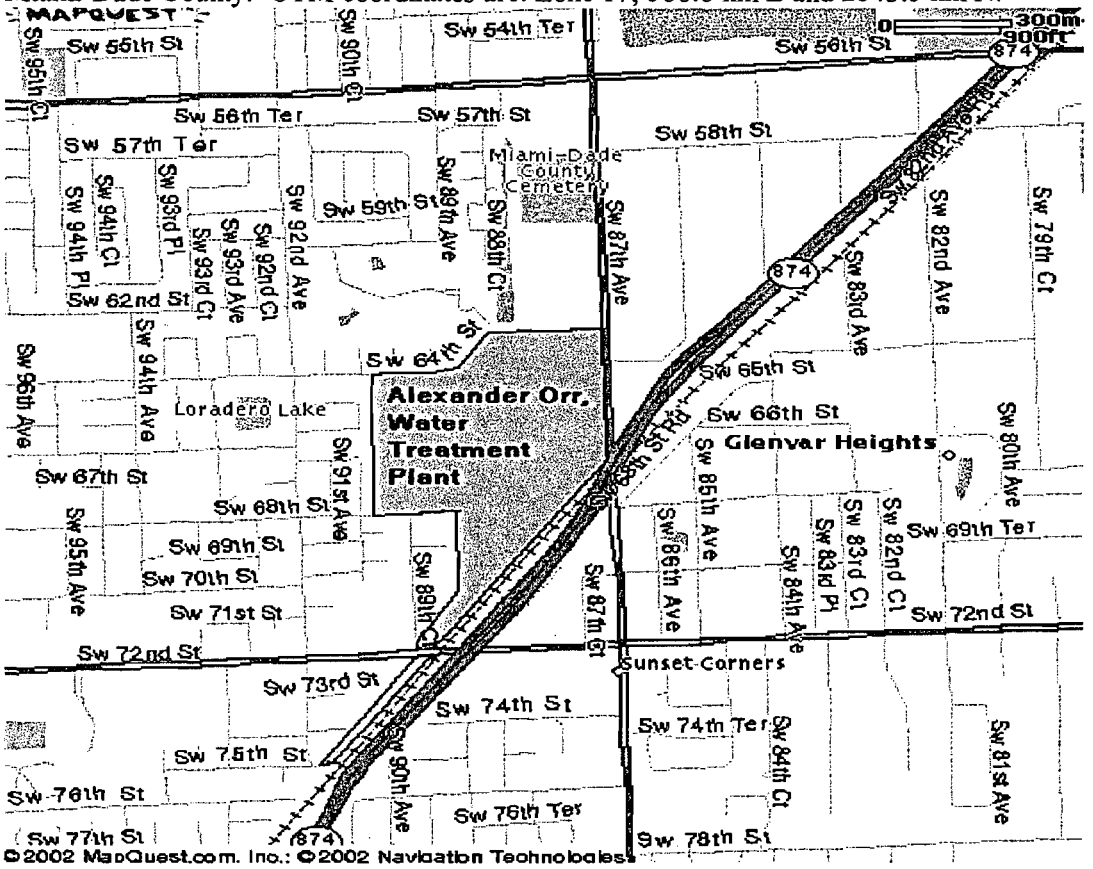
1.2 REVIEWING AND PROCESS SCHEDULE

05/13/02	Receipt of application
06/10/02	Department completeness request
08/05/02	Applicant's response to completeness request
08/05/02	Application complete
09/xx/02	Intent issued

2. FACILITY INFORMATION

2.1 FACILITY LOCATION

The facility is located at the Alexander Orr, Jr. Water Treatment Plant, 6800 SW 87 Avenue, Miami, Miami-Dade County. UTM coordinates are: Zone 17; 566.6 km E and 2843.5 km N.



2.2 STANDARD INDUSTRIAL CLASSIFICATION CODES (SIC)

Industry Group No.	49	Electric, Gas, and Sanitary Services
Industry No.	4941	Water Supply

2.3 FACILITY CATEGORY

The facility, Alexander Orr, Jr. Water Treatment Plant, is a municipally owned water treatment plant providing potable water to the public. The Miami-Dade Water and Sewer Department (WASD) is the sixth largest public utility in the United States, providing direct services to approximately 356,000 retail customers. Wholesale water service is provided to 14 municipalities and wholesale sewer service to 12 of the County's 29 municipalities. Miami-Dade County's current population of 2 million is expected to reach the 3 million mark by the year 2015.[1] The Alexander Orr, Jr. WTP supplies approximately half of the water supply of the WASD system.[2]

This facility is classified as a Major or Title V Source of air pollution because emissions of at least one regulated air pollutant, such as particulate matter (PM/PM_{10}), sulfur dioxide (SO_2), nitrogen oxides (NOx), carbon monoxide (CO), or volatile organic compounds (VOC) exceeds 100 tons per year (TPY).

This facility is not within an industry included in the list of the 28 Major Facility Categories per Table 62-212.400-1, F.A.C. Because emissions are greater than 250 TPY for at least one criteria pollutant, the facility is also a Major Facility with respect to Rule 62-212.400, Prevention of Significant Deterioration (PSD).

This project is exempt from the requirements of Rule 62-212.400, F.A.C., Prevention of Significant Deterioration (PSD) as discussed in this Technical Evaluation and Preliminary Determination.

3.1 PROJECT SCOPE

The scope of this project is to remove existing engines and pumps numbers 1, 2, 3, 4 and 5 and to install new pumps with natural gas fired engines numbers 3, 4 and 5. Existing engine and pump number 1 also served as a prime mover for a 750 KW generator set. Emissions units that will be removed are 001 (engine and pump #1), 002 (engine and pump #2 which were previously taken out of service), 003 (engine and pump #3), 004 (engine and pump #4), and 005 (engine and pump #5).

Emissions units proposed by this permit application are:

Table 1 - Proposed Emission Units

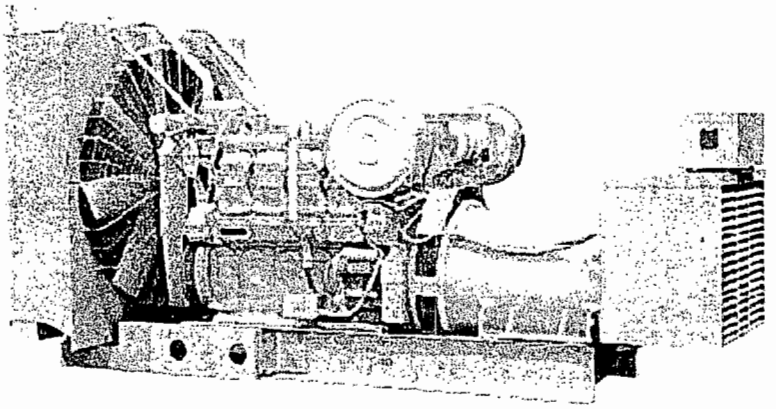
Emissions Unit No.	Emissions Unit Description
023	1332 brake hp diesel fired Caterpillar Model 3508 TA-130, a 4-cycle turbocharged diesel internal combustion (IC) engine driving an electric generator prime rating 900 kW. Maximum heat input rate is 9.2 mmBtu/hr.
018	810 brake hp natural gas fired Caterpillar Model G3512 LE-130 engine for pump 3. Maximum heat input rate is 6.00 mmBtu/hr. Pump has a designed 20 million gallons per day (MGD) water pumping capacity.
019	810 brake hp natural gas fired Caterpillar Model G3512 LE-130 engine for pump 4. Maximum heat input rate is 6.00 mmBtu/hr. Pump has a designed 20 MGD water pumping capacity.
020	2090 brake hp natural gas fired Caterpillar Model G3608 LE engine for pump 5. Maximum heat input rate is 13.70 mmBtu/hr. Pump has a designed 40 MGD water pumping capacity.

3.2 REPLACEMENT EMISSION UNITS

3.2.1 REPLACEMENT OF PUMP / GENERATOR ENGINE 1

Pump engine number one (Emission unit ID No. 001) began service in August 1951 and was coupled to a 750 KW generator and could also be clutched in to drive a pump rated at 20 million gallons per day (MGD). Since this unit served two purposes, the primary of which was to provide the emergency power backup for the pump room, it was normally set up to generate emergency power and only occasionally used. This unit is to be removed and replaced by a Caterpillar Model 3508 TA-130 Series Engine and Generator.

The Model 3508 TA-130 is in Caterpillar's 3500 engine series that, according to Caterpillar are designed to operate reliably at 1800 rpm continuously. The Model 3508 TA-130 engine is a V 8 cylinder engine with a Bore & Stroke of 6.7 x 7.5 in. (170 x 190 mm) and displacement of 2105 cu. in. (34.5 liters). This is a turbocharged engine, and power output at the design aftercooler operating temperature of 130° F ranges from 379 to 1332 bhp at 1800 rpm. Following is a figure of a typical Model 3508 series engine generator package.[3]



Caterpillar 3508 Series Engine and Generator

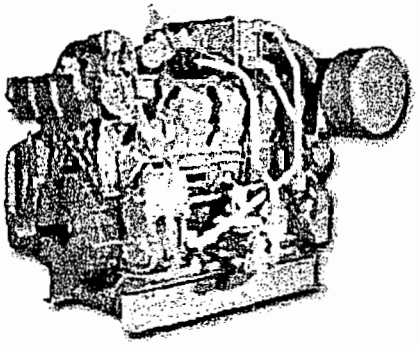
3.2.2 REMOVAL OF PUMP ENGINE 2

Pump engine two (E.U. ID No. 002) began service in August 1951, driving a 20 mgd pump. It has been out of service since early 1990s and parts removed for use to keep the remaining similar units in service. This engine and pump is to be removed and not replaced.

3.2.3 REPLACEMENT OF PUMP ENGINES 3 AND 4

Pump engine numbers 3 & 4 (E.U. ID Nos. 003-004) also began service in August 1951, driving 20 mgd pumps. These engines and pumps are to be removed and replaced by Caterpillar Model G3512 LE-130 engines coupled to Flowserve Model 16LNC28 high service pumps.

The Model G3512 is in Caterpillar's G3500 engine series that, according to Caterpillar are designed to operate reliably at 900 to 1400 rpm continuously. The Model G3512 LE-130 engine is a V 12 cylinder engine with a Bore & Stroke of 6.7 x 7.5 in. (170 x 190 mm) and displacement of 3158 cu. in. (51.8 liters). This is a turbocharged engine and power output at the design aftercooler operating temperature of 130° F ranges from 610 bhp to 945 bhp. Following is a figure of a typical 3500 series engine.[4]

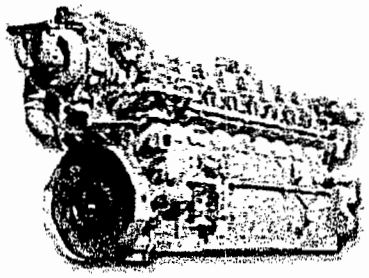


Caterpillar G3500 Series Engine

3.2.3 REPLACEMENT OF PUMP ENGINE 5

Pump engine number five (E.U. ID Nos. 005) began service in August 1951, driving a 40 mgd pump. This engines and pump is to be removed and replaced by Caterpillar Model G3608LE TA-130 engine and a Flowserve Model 600LNEC1150 high service pump rated at 40 million gallons per day.

The Model G3608LE TA-130 engine is an eight-cylinder engine in Caterpillar's G3600 series natural gas fueled engines. Caterpillar characterizes this series as high horsepower, high torque engines that are designed for reliable operation, fuel economy and low emissions. The Model G3608LE TA-130 has an in-line cylinder arrangement, with a bore and stroke of 11.81 x 11.81 in. (300 x 300 mm) and displacement of 10,350 cu. in (143 liters). This is a turbocharged engine, and power output at the design aftercooler operating temperature of 130° F ranges from 1555 bhp to 2225 bhp at 700 rpm to 1000 rpm. Following is a figure of a typical ATGL series engine.[5]



Typical Caterpillar G3600 Series Engine

4. PROJECT EMISSIONS

The emissions associated with this project are the typical pollutants from combustion of natural gas in internal combustion reciprocating engines. The primary pollutants associated with this project are NOx and CO. Because this project essentially consists of replacing existing engines with new engines, a comparison of past actual to future potential emissions for the pollutants expected to be emitted from these engines was performed. The existing engines are fuel oil fired internal combustion reciprocating engines. With the exception of the pump/generator which will be replaced with a fuel oil fired standby generator, units will be replaced with natural gas fired internal combustion reciprocating engines, that are expected to emit much less NOx and CO on a lb/hr basis than the existing engines. This is confirmed by the past

actual to future potential analysis, which also demonstrates that the project is not subject to the requirements of PSD.

4.1 ACTUAL EMISSIONS FOR EXISTING UNITS

A two-year period from April 1998 to March 2000 was used for the estimate of past actual emissions. This was the last period that all engines were operational, and is most reflective of operations prior to modifications to the east pump room. The existing engines operated far less than 8760 hours per year, average, in this period. As noted previously, engine and pump #2 were previously removed from service but are still on-site; for the period chosen this engine and pump set did not operate, so no emissions were estimated from engine #2. In the period chosen, pump engine #1 operated an average of 142.5 hours per year, pump engine #2 was zero, pump engine #3 was 1,306.3 hours per year, pump engine #4 was 1,543.0 hours per year, and pump engine #5 was 2,513.8 hours per year. Actual past emissions were estimated from fuel consumption, operating hours and past emission test results for these units.

4.1.1 MOST RECENT EMISSIONS TESTING FOR EXISTING UNITS

Emissions tests of the existing units were conducted in 1997 and 1998 for the determination of visible and nitrous oxides emissions. A summary of the nitrous oxides (NOx) emission results is included in the tabulation below:

Table 2 - Summary of Past Emissions Test Results
NOx Testing 1997 & 1998, Emissions in Lbs/MMBtu.

Pump Engine	No. 1	No. 3	No.4	No. 5
1997	2.12	1.83	2.95	2.60
1998	2.26	2.36	2.57	2.29
Average	**2.19**	**2.10**	**2.76**	**2.45**

The average value of test results for the two tests conducted will be used for the purpose of determining the annual NOx emissions of the existing units over the two year period being evaluated, as tests were also taken over a two year period, and more representative of operations than just one test result.

4.1.2 EXISTING UNIT OPERATIONS

Monthly operations of the existing units over a two-year period from April 1998 to March 2000 were selected for the estimate of past actual emissions. This was the last period that all engines were operational, and is most reflective of operations prior to modifications to the east pump room. A tabulation of the monthly fuel consumptions over this period used in the 1998, 1999 and 2000 Annual Operating Reports for Air Pollutant Emitting Facility, Alexander Orr, Jr. Water Treatment Plant is presented Table 3 below:

Table 3 - Fuel Consumption (10^3 gallons Diesel)
Pump Room Engines 1 through 5

Month	Pump Engine #1	Pump Engine #3	Pump Engine #4	Monthly Total Engines 3&4	Pump Engine #5
Apr-98	0.543	2.806	4.449	7.255	3.480
May-98	-	0.992	5.921	6.913	4.620
Jun-98	-	0.589	5.301	5.890	8.280
Jul-98	0.233	0.605	4.464	5.069	3.900

Aug-98	0.837	3.999	5.580	9.579	21.360
Sep-98	1.891	5.332	8.773	14.105	41.580
Oct-98	0.217	5.503	8.091	13.594	43.980
Nov-98	-	6.851	4.666	11.517	42.570
Dec-98	-	6.696	2.201	8.897	8.220
Jan-99	-	7.316	2.325	9.641	32.280
Feb-99	0.093	2.356	4.185	6.541	6.000
Mar-99	-	7.239	2.294	9.533	3.840
Apr-99	0.155	7.130	0.744	7.874	3.720
May-99	0.806	9.486	-	9.486	6.540
Jun-99	1.240	3.162	-	3.162	8.940
Jul-99	0.744	1.674	1.395	3.069	4.500
Aug-99	0.093	3.147	2.697	5.844	9.540
Sep-99	0.372	3.751	0.279	4.030	7.380
Oct-99	-	2.356	-	2.356	8.460
Nov-99	-	-	4.836	4.836	11.940
Dec-99	0.434	-	7.006	7.006	6.840
Jan-00	0.168	-	6.024	6.024	4.200
Feb-00	0.576	-	6.096	6.096	3.864
Mar-00	0.168	-	3.720	3.720	1.512
Annual Average Apr 98 - Mar 00	4.285	40.495	45.524	86.019	148.773

These annual average fuel consumptions for the two year period will be used with the average emission test results of each engine for NOx emissions and using emission factors obtained from the EPA Factor Inventory REtrieval (FIRE[6])

4.1.3 ANNUAL EMISSIONS FOR EXISTING UNITS

The annual emissions for the existing units based average operations, emission tests and emission factors from the EPA FIRE database is provided in Table 4 below:

Table 4 - Existing Annual Pump Engine Emissions

				Average Annual Operations April 1998 - March 2000					
				Pump / Gen Engine 1	Pump Engine 3	Pump Engine 4	Sum Pump Engines 3 & 4	Pump Engine 5	Total Units 1, 3, 4 & 5
Average Annual Fuel consumption (1000) gallons				4.285	40.495	45.524	86.019	148.773	234.8
MMbtus based on 138 / SCC Unit (1000 gallons)				591	5,588	6,282	11,870.6	20,531	32,401
Average Nitrogen Oxides (NOx) Emissions Test Results (Lbs/mmBTU)				2.19	2.10	2.76		2.45	
	Emission Factor	Units	Source or SCC[7]	Annual Emissions in Tons					
Nitrogen Oxides (NOx)	-	-	Test Results	0.65	5.87	8.67	14.54	25.15	40.33
Carbon Monoxide (CO)	1.11E+02	Lbs/1000gals	20200401	0.24	2.25	2.53	4.77	8.26	13.27
PM, Total	9.55E+00	Lbs/1000gals	20200401	0.02	0.19	0.22	0.41	0.71	1.14

PM_{10}, Total	7.85E+00	Lbs/1000gals	20200401	0.02	0.16	0.18	0.34	0.58	0.94
Sulfur Oxides (SOx)	6.90E+00	Lbs/1000gals	20200401	0.00	0.01	0.01	0.01	0.03	0.04
VOC, Total	1.37E+01	Lbs/1000gals	20200401	0.03	0.28	0.31	0.59	1.02	1.64

Notes:
Emissions Factors based on Emissions Testing. EPA FIRE database Source Classification Codes
Emissions (tons/yr) = (emission factor [lbs/unit]) x (units) / 2000 lbs/ton

4.2 POTENTIAL EMISSIONS OF REPLACEMENT UNITS

Future potential emissions were estimated for the replacement engines based on operating at maximum capacity for 8760 hours per year, except for the emergency generator, which was limited to a maximum operation of 500 hours. Emissions were estimated using emission factors obtained from the EPA FIRE database and by interpolating manufacturer supplied factors for NOx and CO for the anticipated operating loads.

4.2.1 OPERATIONAL CONSIDERATIONS OF REPLACEMENT UNIT LOADING

Due to the nature of emergency generator operations and the minimum number of hours of operation proposed a detailed analysis to determine potential operations at less than full load was not done. However, review of manufacturer supplied emission rates indicate that hourly emissions of the critical pollutants of concern decrease under lower loads.

Since the pump engine loads vary depending on the operational discharge pressures of the pump room and the specific test curves of the pump model being installed, historic hourly average discharge pressures for the pump room were obtained from the MDWASD Supervisory Control And Data Acquisition (SCADA) System. To better utilize this data in a manner that would provide a useful indicator of an average operating pressure (and thus engine loading) over a longer period of time, it was agreed by the FDEP that a 30 day rolling average discharge pressure could be used to determine the normal pump engine operation loads for the purpose of determining annual potential emissions.

Beginning in 2001, the rolling average discharge pressures dropped dramatically and variability increased. This is attributed to two abnormalities; Phase II drought restrictions were effective January 2001 until October 2001 (pressures were decreased to reduce water consumption and loss) and beginning in March 2001 pump engines 1 through 4 were taken out of service pending replacement.

Prior to this abnormal period of operations, the rolling average discharge pressure ranges between 75.2 psi and 72 psi over the two-year period from January 1, 1999 to December 31, 2000.

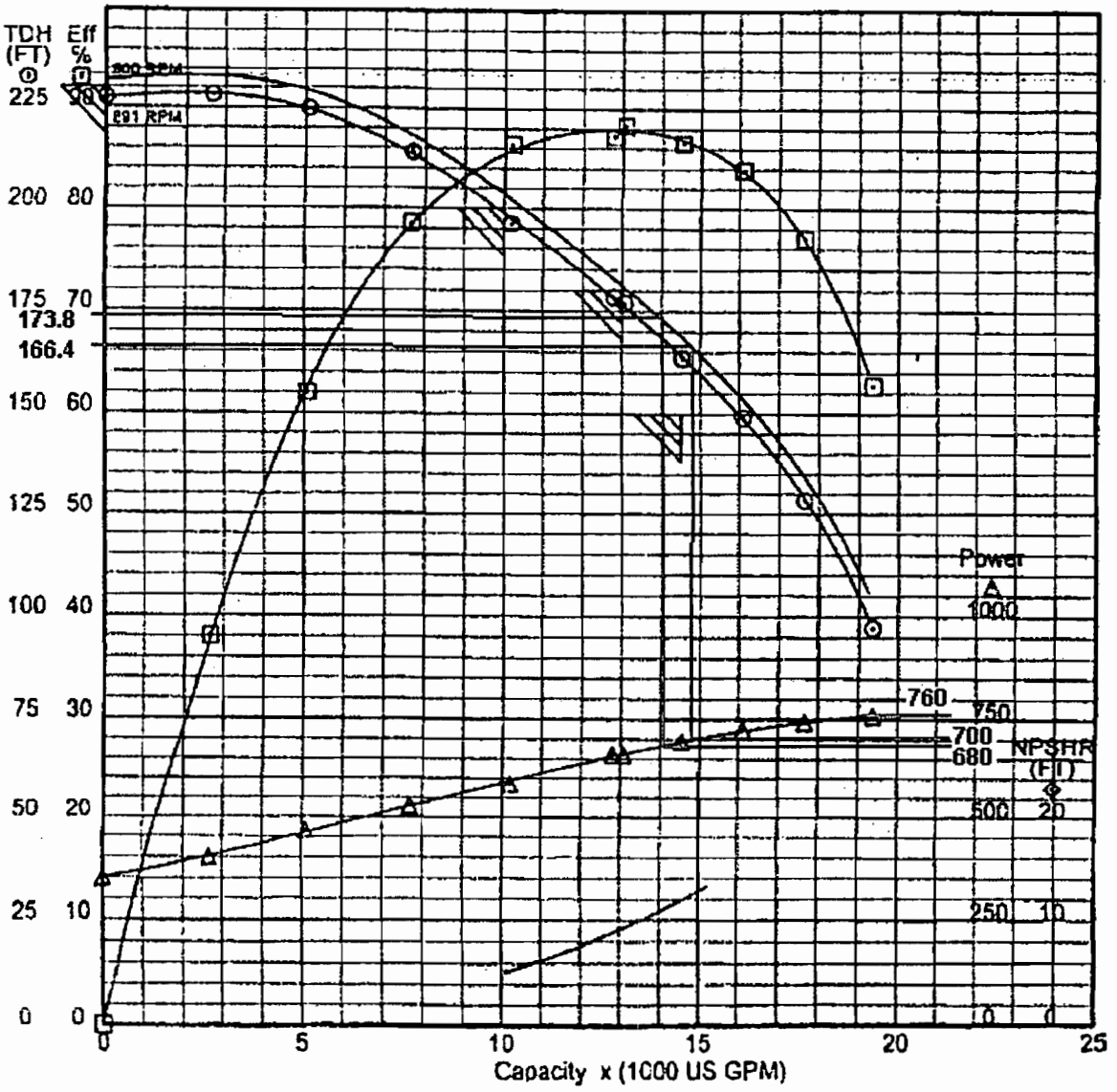
4.2.2 DETERMINATION OF PUMP LOADS

Because pump horsepower input requirements are dependent on the operational discharge pressures. The required horsepower inputs for normal operations was determined using the pump performance test curves for the pumps to be installed and the high and low rolling average discharge pressures of 75.2 and 72 psi (173.8 and 166.4 TDH respectively).

4.2.2.1 PUMPS 3 AND 4

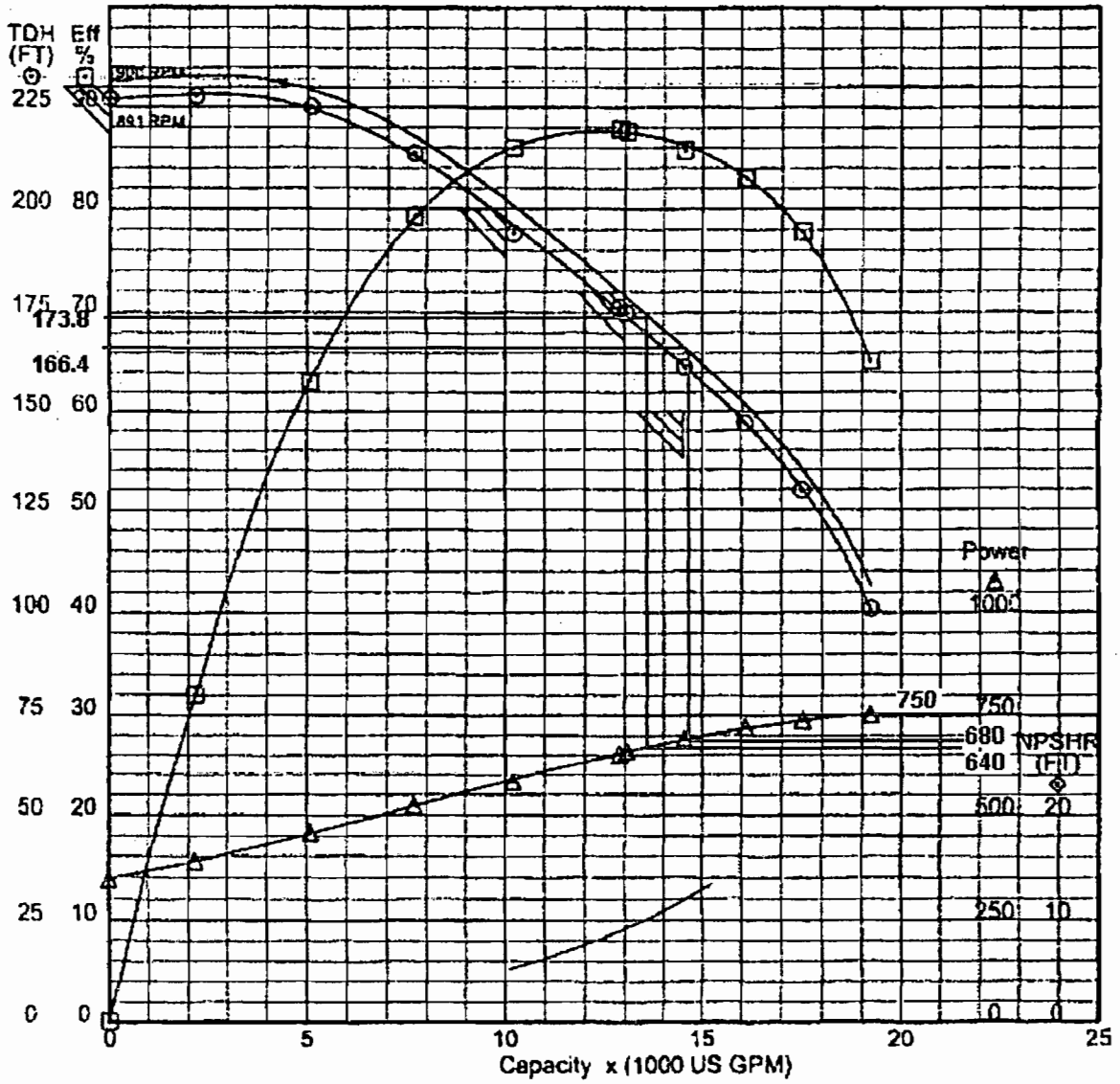
Pump numbers 3 and 4 are the same model, however slight differences in performance test curves required the analysis of both to obtain the horsepower input requirements.

The performance test curves for these two pumps are provided in the following two figures:



Pump Curve 16LNC28 Pump Serial No. 0110MS001385-1

Based on this performance curve the maximum potential load occurring at pump run out occurs at 760 bhp. The normal operating range based on the high and low rolling average discharge pressures of 173.8 and 166.4 TDH is 700 and 680 bhp.



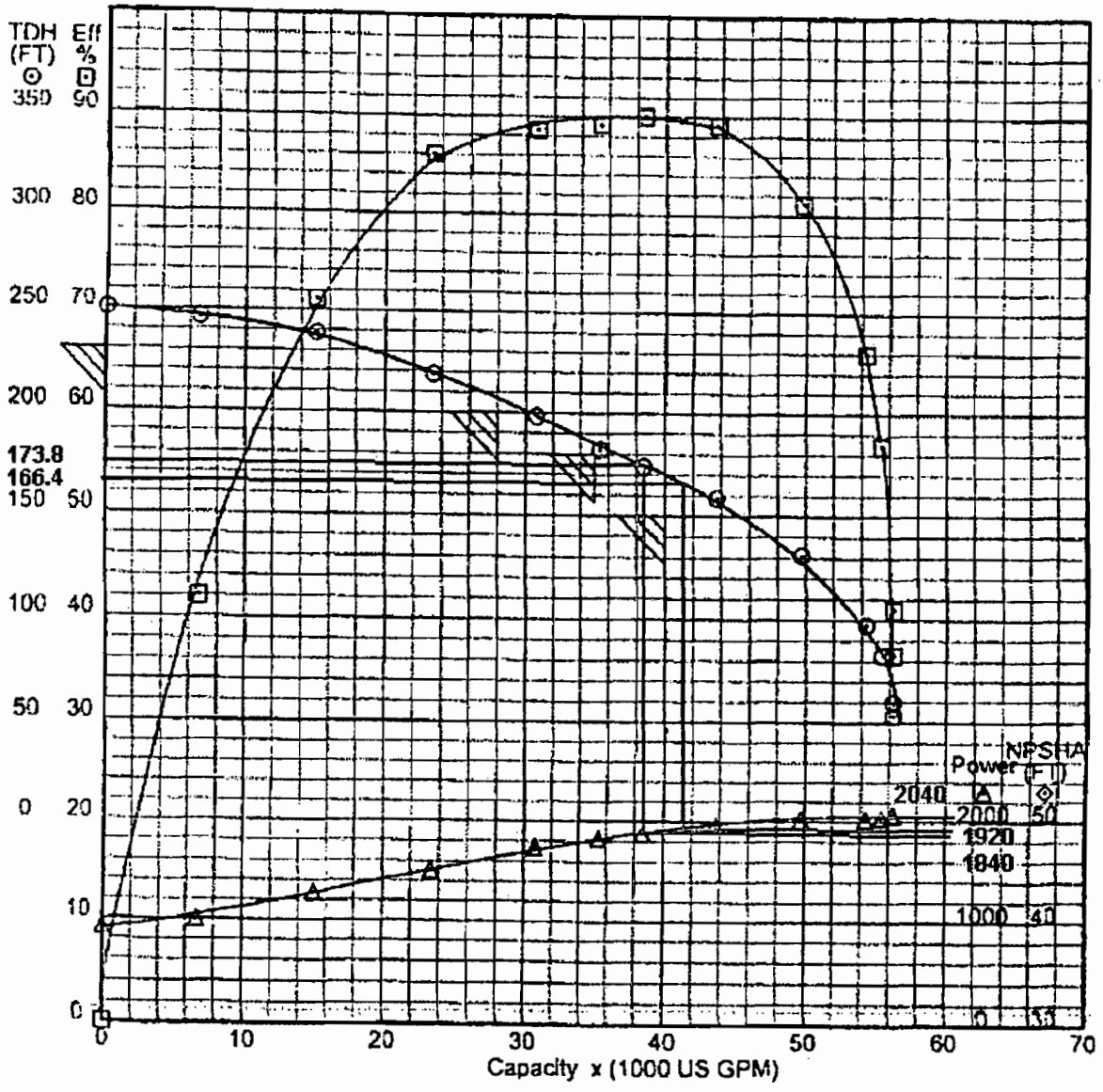
Pump Curve 16LNC28 Pump Serial No. 0110MS001385-2

Based on this performance curve the maximum potential load occurring at pump run out occurs at 750 bhp. The normal operating range based on the high and low rolling average discharge pressures of 173.8 and 166.4 TDH is 680 and 640 bhp.

For the purposes of determining maximum and potential emissions, 760 bhp will be used for the maximum hourly load and the high of 700 bhp and low of 640 bhp will be used for the average loads to determine the annual potential emissions during operations.

4.2.2.2 PUMP 5

The performance test curve used to obtain the horsepower input requirements for pump number 5 is provided in the following figure below:



Pump Curve 600LNEC1150 Pump Serial No. 0110MS001386-1

Based on this performance curve the maximum potential load occurring at pump run out at approximately 2020 bhp. The normal operating range based on the high and low rolling average discharge pressures of 173.8 and 166.4 TDH is approximately 1920 and 1840 bhp. For the purposes of determining maximum and potential emissions, 2020 bhp will be used for the maximum hourly load and the high of 1920 bhp and low of 1840 bhp will be used for the average loads to determine the annual potential emissions during operations.

4.2.3 EFFECTS OF OPERATING AT OTHER THAN FULL LOADS ON EMISSIONS

Caterpillar provides operating parameters and certain pollutant emissions factors for specific engine loads. To further analyze the effects of operating the engines at other than full loads on emissions and other operating parameters at loads other than specifically provided, values were interpolated for the range of loads anticipated for each of the different replacement engines.

4.2.3.1 REPLACEMENT ENGINE NO. 1 - CATERPILLAR MODEL 3508

Table 5 summarizes the manufacturer supplied operating parameters for the Caterpillar 3508 Engine and Generator in regular text and interpolated values in italics:

Table 5
Replacement Engine No. 1 - Caterpillar Model 3508

Engine Rating Data	% load	100%	90.0%	*85.0%*	80.0%	75%	50%
Generator (w/ fan)	EKW	900	807	*761*	714	675	450
Engine Power	bhp	1332	1199	*1132*	1065	1009	691
Engine Data							
Specific Fuel Consumption (BSFC)	Gals/hr	66.5	60	*56*	53	49.8	35.2
Air Flow (Wet, @77 F, 28.8 in HG)	SCFM	2821	2662	*2583*	2503	2436	1886
Exhaust Stack Temperature	°F	884	840	*817*	795	776	723
Exhaust Gas Flow (Wet, @ stack temperature, 29.7 in Hg)	CFM	7327	6693	*6373*	6054	5787	4269
Engine Emissions Data							
Nitrous Oxides (NO2)	g/bhp-hr	12.77	13.50	*13.93*	14.42	14.88	16.87
	lb/hr	37.46	35.65	*34.74*	33.83	33.07	25.67
Carbon Monoxide (CO)	g/bhp-hr	0.72	0.66	*0.62*	0.59	0.55	0.55
	lb/hr	2.10	1.74	*1.56*	1.37	1.22	0.83
Total Hydrocarbons (THC)	g/bhp-hr	0.23	0.27	*0.30*	0.32	0.35	0.30
	lb/hr	0.68	0.72	*0.74*	0.75	0.77	0.46
Particulate Matter (PM)	g/bhp-hr	0.11	0.11	*0.11*	0.11	0.11	0.12
	lb/hr	0.31	0.29	*0.27*	0.26	0.25	0.19

The replacement generator is anticipated to operate between 100 to 75 percent load under normal conditions. Based on this range, the maximum emission rates of the pollutants provided in the table are underlined and will be used in determining the annual potential emissions for these units.

Table 6 summarizes the emissions from the Caterpillar 3508 Engine and Generator restricted to operating no more than 500 hours per year.

Table 6 – Potential Annual Emissions 900 KW GenSet

			Hours of Operation	500
			Fuel Consumption in 1000gals/hr	0.0665
			Annual Fuel consumption in 1000gals	33.25
			Annual Heat Input (mmBtus) based on or 138 /1000 gals	4,589
	Emission Factor	Units	Source, SCC[8]	Annual Emissions in Tons
Nitrogen Oxides (NOx)	37.46	Lbs/Hr	Manufacturer	9.40
Carbon Monoxide (CO)	3.10	Lbs/Hr	Manufacturer	0.80
Particulate Matter (PM)	0.310	Lbs/Hr	Manufacturer	0.08
Particulate Matter (PM_{10})	0.310	Lbs/Hr	Manufacturer	0.08
Sulfur Oxides (SOx)	6.90E+00	Lbs/1000gals	20200401	0.11
Volatile Organic Compounds (VOC)	1.37E+01	Lbs/1000gals	20200401	0.20

Notes:
Emissions Factors based on Manufacturer. EPA FIRE database Source Classification Codes
Emissions (tons/yr) = (emission factor [lbs/unit]) x (units) / 2000 lbs/ton

4.2.3.2 REPLACEMENT PUMP ENGINES 3 AND 4 - CATERPILLAR G3512LE

Table 7 summarizes the manufacturer supplied operating parameters for the G3512LE TA-130 in regular text, with the interpolated values provided in italics for loads of 760, 700 and 640 bhp:

Table 7 - Replacement Pump Engines Nos. 3 and 4 - Caterpillar Model G3512LE

Engine Rating Data	% load	100%	*93.8%*	*86.4%*	*79.0%*	75%	50%
Engine Power (w/o fan)	bhp	810	*760*	*700*	*640*	607	405
Specific Fuel Consumption (BSFC)	BTU/bhp-hr	7407	*7455*	*7512*	*7569*	7600	7937
Air Flow (Wet, @77 F, 28.8 in HG)	SCFM	1668	*1555*	*1419*	*1284*	1209	827
Exhaust Stack Temperature	°F	801	*797*	*793*	*788*	786	777
Exhaust Gas Flow (Wet, @ stack temperature, 29.7 in Hg)	CFM	4260	*3964*	*3610*	*3255*	3060	2080
Engine Emissions Data							
Nitrous Oxides (NO2)	g/bhp-hr	2.00	*2.32*	*2.70*	*3.09*	3.30	3.30
	lb/hr	3.57	*3.88*	*4.17*	***4.35***	4.41	2.94
Carbon Monoxide (CO)	g/bhp-hr	1.60	*1.62*	*1.65*	*1.68*	1.70	1.90
	lb/hr	2.85	***2.72***	***2.55***	*2.37*	2.27	1.69
Total Hydrocarbons (THC)	g/bhp-hr	3.10	*3.03*	*2.94*	*2.85*	2.80	3.20
	lb/hr	5.53	***5.07***	***4.53***	*4.02*	3.74	2.85
Non-Methane Hydrocarbons (NMHC)	g/bhp-hr	0.47	*0.46*	*0.44*	*0.43*	0.42	0.48
	lb/hr	0.84	***0.77***	***0.68***	*0.60*	0.56	0.43

The replacement engines are anticipated to operate between 86.4 to 79.0 percent load on average under normal conditions. Based on this normal operating range, the maximum emission rates of the pollutants provided in the table are underlined and will be used in determining the annual potential emissions for these units. The bold values in the table are maximum values possible during transient pumping operations and are used for a maximum hour emission rate of a pollutant.

Table 8 summarizes the emissions from the Replacement Pump Engines Nos. 3 and 4 - Caterpillar Model G3512LE TA-130 with no operating restrictions placed on the units, operating under average annual loading and pumping conditions.

Table 8 – Potential Annual Emissions Replacement Pump Engines 3 and 4

				Pump Engine 3 G3512	Pump Engine 4 G3512	Sum Pump Engines 3 & 4
			Hours of Operation	8,760	8,760	17,520
			Fuel Consumption in MCF/hr	5.258	5.258	
			Annual Fuel consumption in MMCF	43.87	43.87	87.74
			Annual Heat Input (mmBtus) based on 1050/ MMCF	46,061	46,061	92,122
	Emission Factor	Units	Source, SCC[9]	Annual Emissions in Tons		
Nitrogen Oxides (NOx)	4.35	Lbs/Hr	Manufacturer	19.10	19.10	38.20
Carbon Monoxide (CO)	2.55	Lbs/Hr	Manufacturer	11.20	11.20	22.40
PM, Filterable	1.00E+01	Lbs/MMCF	20300201	0.22	0.22	0.44
PM_{10}, Filterable	1.00E+01	Lbs/MMCF	20300201	0.22	0.22	0.44
Sulfur Oxides (SOx)	6.00E-01	Lbs/MMCF	20300201	0.01	0.01	0.02
Volatile Organic Compounds (VOC)	1.16E+02	Lbs/MMCF	20300201	2.50	2.50	5.00

Notes:
Emissions Factors based on Manufacturer. EPA FIRE database Source Classification Codes
Emissions (tons/yr) = (emission factor [lbs/unit]) x (units) / 2000 lbs/ton

4.2.3.3 REPLACEMENT PUMP ENGINE 5 - CATERPILLAR G3608LE

Table 9 summarizes the manufacturer supplied operating parameters for the G3608LE TA-130 in regular text, with the interpolated values provided in italics for loads of 2020, 1920 and 1840 bhp:

Table 9 - Replacement Pump Engine No. 5 - Caterpillar Model G3608 LE

Engine Rating Data	% load	100%	*91.7%*	*86.3%*	*82.7%*	75%	50%
Engine Power (w/o fan)	bhp	2225	*2040*	*1920*	*1840*	1669	1113
BSFC	BTU/bhp-hr	6810	*6885*	*6933*	*6966*	7035	7550
Air Flow (scfm @ 77°F, 13.9 psia)		6136	*5663*	*5356*	*5152*	4715	3143
Exh Flow (cfm @ stack T, 14.5 psia)		14867	*13783*	*13080*	*12612*	11610	8048
Exhaust Stack Temp (F°)		847	*854*	*859*	*862*	868	918
Fuel Flow (scfh 4 @ 60°F, 14.7 psia)		16743	*15488*	*14674*	*14132*	12972	9281
Engine Emissions Data							
NOx (as NO_2)	g/bhp-hr	0.70	*0.70*	*0.70*	*0.70*	0.70	0.70
	lb/hr	3.43	*3.15*	*2.96*	*2.84*	2.57	1.72
CO	g/bhp-hr	1.90	*1.90*	*1.90*	*1.90*	1.90	1.90
	lb/hr	9.31	*8.54*	*8.04*	*7.70*	6.98	4.66
HC (Total)	g/bhp-hr	5.95	*6.07*	*6.14*	*6.19*	6.30	6.50
	lb/hr	29.16	*27.26*	*25.97*	*25.10*	23.16	15.94
HC(Non-Methane)	g/bhp-hr	0.89	*0.91*	*0.92*	*0.93*	0.95	0.98
	lb/hr	4.36	*4.09*	*3.90*	*3.78*	3.49	2.40

The replacement engine is anticipated to operate between 86.3 to 82.7 percent load on average under normal conditions. Based on this normal operating range, the maximum emission rates of the pollutants provided in the table are underlined and will be used in determining the annual potential emissions for these units. The bold values in the table are maximum values possible during transient pumping operations and are used for a maximum hour emission rate of a pollutant.

Table 10 summarizes the emissions from the Replacement Pump Engine No. 5 - Caterpillar Model G3608 LE TA-130 with no operating restrictions placed on the unit, operating under average annual loading and pumping conditions.

Table 10 - Potential Annual Emissions Replacement Pump Engine 5

			Hours of Operation	8,760
			Fuel Consumption in MCF/hr	13.312
			Annual Fuel consumption in MMCF	111.06
			Annual Heat Input (mmBtus) based on 1050/ MMCF	116,615
	Emission Factor	Units	Source, SCC[10]	Annual Emissions in Tons
Nitrogen Oxides (NOx)	2.96	Lbs/Hr	Manufacturer	13.00
Carbon Monoxide (CO)	8.04	Lbs/Hr	Manufacturer	35.20
PM, Filterable	1.00E+01	Lbs/MMCF	20300201	0.56
PM_{10}, Filterable	1.00E+01	Lbs/MMCF	20300201	0.56
Sulfur Oxides (SOx)	6.00E-01	Lbs/MMCF	20300201	0.03
Volatile Organic Compounds (VOC)	1.16E+02	Lbs/MMCF	20300201	6.40

Notes:
Emissions Factors based on Manufacturer. EPA FIRE database Source Classification Codes
Emissions (tons/yr) = (emission factor [lbs/unit]) x (units) / 2000 lbs/ton

4.2.4 ANNUAL POTENTIAL EMISSIONS OF REPLACEMENT UNITS

Table 11 summarizes the annual potential emissions for all replacement units

Table 11 - Annual Potential Emissions of Replacement Units

	900 KW GenSet	Pump Engines 3 & 4	Pump Engine 5	Total 900 KW GenSet & Pump Engines 3,4 & 5
Nitrogen Oxides (NOx)	9.40	38.20	13.00	60.60
Carbon Monoxide (CO)	0.80	22.40	35.20	58.40
PM	0.08	0.44	0.56	1.08
PM_{10}	0.08	0.44	0.56	1.08
Sulfur Oxides (SOx)	0.11	0.02	0.03	0.16
Volatile Organic Compounds (VOC)	0.20	5.00	6.40	11.60

4.3 SUMMARY OF PAST ACTUAL TO FUTURE EMISSIONS

Table 12 summarizes the potential maximum emissions increases of air pollutants, comparing past actual to future potential emissions in TPY:

Table 12
Summary of Past Actual to Future Emissions in Tons per Year

Pollutant	Past Actual Existing Engines	Future Potential New Engines	Maximum Emissions Change	PSD Significance Levels[11]	Subject to PSD Review?
NOx	40.33	60.60	20.27	40	No
CO	13.27	58.40	45.13	100	No
PM	1.14	1.08	(0.06)	25	No
PM_{10}	0.94	1.08	0.14	15	No
SO_2	0.04	0.16	0.12	40	No
VOC	1.64	11.60	9.96	40	No

The proposed project results in net emissions decreases or less-than-significant increases in PSD pollutants. Emission decreases will occur for sulfur dioxide (PM). Emission increases of carbon monoxide (CO), particulate matter (PM_{10}), volatile organic compounds (VOC), and nitrogen oxides (NOx) will be less than the significant emission levels per Table 62-212.400-2, F.A.C. This project will emit negligible quantities of sulfuric acid mist (H_2SO_4 mist or SAM), fluorides, beryllium, mercury and lead. Therefore the modification is not subject to PSD.

5. RULE APPLICABILITY

The proposed project is subject to preconstruction review requirements under the provisions of Chapter 403, Florida Statutes, and Chapters 62-4, 62-204, 62-210, 62-212, 62-214, 62-296, and 62-297 of the Florida Administrative Code (F.A.C.).

This facility is located in an area designated, in accordance with Rule 62-204.340, F.A.C., as attainment for the criteria pollutants ozone, PM_{10}, carbon monoxide, sulfur dioxide, and nitrogen dioxide; designated as unclassifiable for lead; and also designated as a maintenance area for ozone.

The proposed project is not subject to review under Rule 62-212.400., F.A.C., Prevention of Significant Deterioration (PSD) as discussed above.

Rule 62-4.030, F.A.C., prohibits modification of any existing emissions unit without first receiving a permit. It further specifies that a permitted installation may only be modified in a manner that is consistent with the terms of such a permit. Rule 62-210.200, F.A.C., defines "modification" to mean generally a change that results in an increase in actual emissions of air pollutants. As discussed above, emissions will increase, although not significantly. Rules 62-210.300(1) and 62-212.300(1)(a), F.A.C., also reiterate the requirement for construction permits. As noted above, future potential emissions were estimated based on unrestricted operation of the new engines. Since future potential emissions were estimated with no restrictions on operating hours or fuel consumption, such limits are not required in the construction permit for this project. There is no unit-specific emission limiting standards applicable to the natural gas fired internal combustion units under Rule 62-296.570(4)(b)9, F.A.C. The NOx RACT requirement under Rule 62-296.570(4)(b)7, F.A.C. does apply to the oil-fired diesel generator unit. Therefore, the permit will authorize installation of the new engines to replace the existing engines, but will not subject the new natural gas engines to unit-specific limitations on emissions or operation. The Department will require only initial testing on two of the three natural gas engines for NOx to verify the emission numbers provided in the

application. The diesel fueled generator unit will be subject to unit-specific RACT NOx emission limitation of 4.75 lb/million BTU.

The emission units affected by this permit shall comply with all applicable provisions of the Florida Administrative Code (including applicable portions of the Code of Federal Regulations incorporated therein) and, specifically, the following Chapters and Rules.

5.1 STATE REGULATIONS

Chapter 62-4	Permits.
Rule 62-204.220	Ambient Air Quality Protection
Rule 62-204.240	Ambient Air Quality Standards
Rule 62-204.800	Federal Regulations Adopted by Reference
Rule 62-210.200	Definitions
Rule 62-210.300	Permits Required
Rule 62-210.350	Public Notice and Comments
Rule 62-210.370	Reports
Rule 62-210.550	Stack Height Policy
Rule 62-210.650	Circumvention
Rule 62-210.700	Excess Emissions
Rule 62-210.900	Forms and Instructions
Rule 62-212.300	General Preconstruction Review Requirements
Rule 62-213	Operation Permits for Major Sources of Air Pollution
Rule 62-296.320	General Pollutant Emission Limiting Standards

6. AIR POLLUTION CONTROL TECHNIQUES

Emissions from this project are those that typically result from combustion of natural gas and diesel fuel in four-cycle internal combustion reciprocating engines: NOx, PM/PM10, CO, VOC and SO2. SO2 is not a pollutant emitted in significant quantity by natural gas fuel engines. Combustion control is the technique used to control emissions from these proposed replacement engines. Combustion controlled by electronic engine controls, which are discussed in more detail below.

6.1 AIR POLLUTANTS[12]

6.1.1 NITROGEN OXIDES (NOX) EMISSIONS

Nitrogen oxides are formed through three fundamentally different mechanisms. The principal mechanism of NOx formation with gas-fired engines is thermal NOx. The thermal NOx mechanism occurs through the thermal dissociation and subsequent reaction of nitrogen (N2) and oxygen (O2) molecules in the combustion air. Most NOx formed through the thermal NOx mechanism occurs in high-temperature regions in the cylinder where combustion air has mixed sufficiently with the fuel to produce the peak temperature fuel/air interface. The second mechanism, called prompt NOx, occurs through early reactions of nitrogen molecules in the combustion air and hydrocarbon radicals from the fuel. Prompt NOx reactions occur within the flame and are usually negligible compared to the level of NOx formed through the thermal NOx mechanism. The third mechanism, fuel NOx, stems from the evolution and reaction of fuel-bound nitrogen compounds with oxygen. Most distillate oils, have no chemically bound, and natural gas has negligible chemically bound fuel N2 and essentially all NOx formed is thermal NOx.

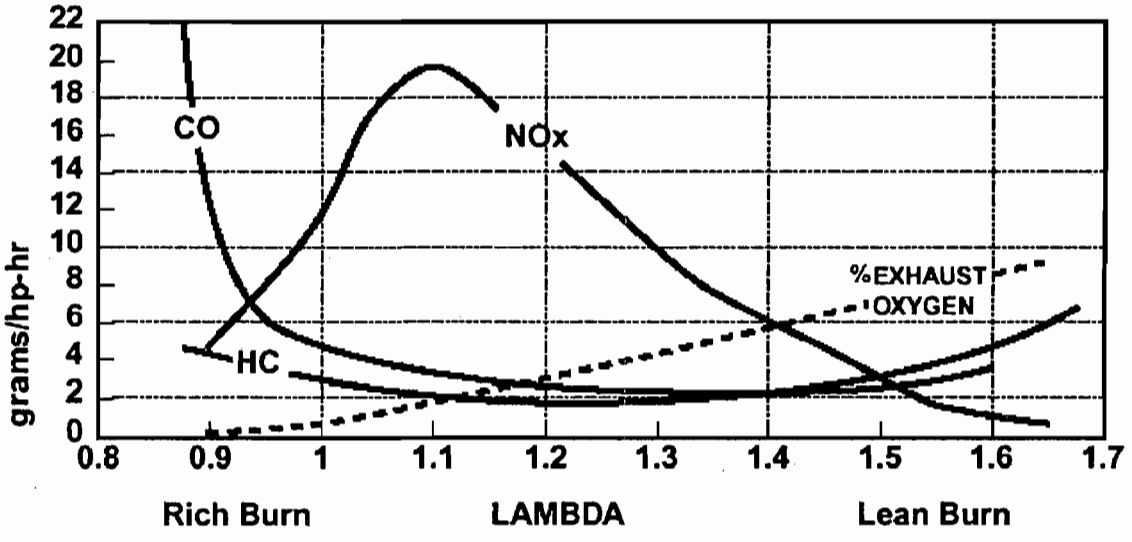
Essentially all NOx formed in natural gas-fired reciprocating engines occurs through the thermal NOx mechanism. The formation of NOx through the prompt NOx mechanism may be significant only under

highly controlled situations in rich-burn engines when the thermal NOx mechanism is suppressed. The rate of NOx formation through the thermal NOx mechanism is highly dependent upon the stoichiometric ratio, combustion temperature, and residence time at the combustion temperature. Maximum NOx formation occurs through the thermal NOx mechanism near the stoichiometric air-to-fuel mixture ratio since combustion temperatures are greatest at this air-to-fuel ratio.

Nitrogen oxides form in the combustion process as a result of the dissociation of molecular nitrogen and oxygen to their atomic forms and subsequent recombination into seven different oxides of nitrogen. Thermal NOx forms as a result of high temperatures in the combustion chamber (cylinders in IC engines). Increased combustion temperatures lead to increased NOx formation. In internal combustion engines, combustion temperature is dependent upon the inlet temperature of the intake air used in combustion, the ratio of air to fuel, and the formation of thermal NOx is highly dependent on this ratio.

Fuel NOx is formed when fuels containing chemically bound nitrogen are burned. This phenomenon is not important when combusting natural gas because natural gas has little or no fuel nitrogen. Because natural gas will be the only fuel used in the pump engines, the fuel NOx phenomenon is not important for this potion of the project.

The following figure illustrates the effect of the air/fuel ratio on emissions of NOx in natural gas fired internal combustion engines. To the rich side of the stoichiometric ratio, NOx decreases because of a lack of oxygen in the combustion chamber and lower combustion temperatures. Fuel quenching occurs under these conditions, which keeps combustion temperatures low. To the lean side of the stoichiometric ratio, NOx reaches a peak where combustion temperature is high and ample oxygen exists for thermal NOx formation. As conditions become leaner (air/fuel ratio increases) the combustion temperature decreases because of air quenching. The lowest NOx emissions occur under the leanest combustion conditions.



Exhaust Emissions from Natural Gas Engines (grams/hp-hr vs. Lambda)[13]

Prestratified charge combustion is a retrofit system that is limited to 4-stroke carbureted natural gas engines. In this system, controlled amounts of air are introduced into the intake manifold in a specified sequence and quantity to create a fuel-rich and fuel-lean zone. This stratification provides both a fuel-rich ignition zone and rapid flame cooling in the fuel-lean zone, resulting in reduced formation of NOx.

6.1.2 PARTICULATE MATTER (PM/PM10) EMISSIONS

White, blue, and black smoke may be emitted from IC engines. Liquid particulates appear as white smoke in the exhaust during an engine cold start, idling, or low load operation. These are formed in the quench layer adjacent to the cylinder walls, where the temperature is not high enough to ignite the fuel. Blue smoke is emitted when lubricating oil leaks, often past worn piston rings, into the combustion chamber and is partially burned. Proper maintenance is the most effective method of preventing blue smoke emissions from all types of IC engines. The primary constituent of black smoke is agglomerated carbon particles (soot). Particulate matter is formed in internal combustion engines primarily through combustion of fuel oil and lubricating oil. The particulate matter emitted from IC engines will mainly be less than 10 microns in diameter (PM10). PM emissions from natural gas fired engines are very low because natural gas is efficiently combusted and contains no ash. Combustion of natural gas under lean fuel conditions results in low PM and PM10 emissions.

6.1.3 CARBON MONOXIDE (CO) EMISSIONS

Carbon monoxide is a colorless, odorless, relatively inert gas formed as an intermediate combustion product that appears in the exhaust when the reaction of CO to CO2 cannot proceed to completion. This situation occurs if there is a lack of available oxygen near the hydrocarbon (fuel) molecule during combustion, if the gas temperature is too low, or if the residence time in the cylinder is too short. The oxidation rate of CO is limited by reaction kinetics and, as a consequence, can be accelerated only to a certain extent by improvements in air and fuel mixing during the combustion process.

Carbon monoxide is emitted from combustion processes due to incomplete fuel combustion. Incomplete combustion occurs when insufficient oxygen exists near the fuel molecule or when quenching of combustion occurs, thus preventing complete conversion of fuel carbon-to-carbon dioxide. Proper combustion design and operation ensure that CO emissions are minimized. The previous figure also illustrates the effect of fuel to air ratio on CO emissions. CO emissions are lowest under combustion conditions that are slightly lean of the stoichiometric ratio because sufficient oxygen is present for complete oxidation of the fuel carbon while temperature is at its greatest. Under fuel rich conditions, there is not sufficient oxygen for complete combustion. CO emissions increase slightly under the leanest combustion conditions because of lower combustion temperatures and lower fuel mixture flammability.

6.1.4 VOLATILE ORGANIC COMPOUND (VOC) EMISSIONS

In natural gas fired IC engines, hydrocarbon emissions are present in exhaust gas because of incomplete combustion of fuel. Natural gas is composed of several gaseous hydrocarbons including methane, ethane, propane, butane and heavier hydrocarbons. A portion of these will pass through the combustion chamber without reacting and will be found in the engine exhaust. Regulated volatile organic compounds (VOC) are comprised of the non-methane portion of the total hydrocarbons, because methane is considered to be not photochemically reactive. Emissions of VOC are similar to CO emissions: higher at operating conditions richer and leaner than the stoichiometric ratio. This is illustrated in the previous figure.

6.1.5 SULFUR OXIDES (SOX) EMISSIONS

Sulfur oxide emissions are a function of only the sulfur content in the fuel rather than any combustion variables. In fact, during the combustion process, essentially all the sulfur in the fuel is oxidized to sulfur dioxide (SO_2). The oxidation of SO_2 yields sulfur trioxide (SO_3), which reacts with water to give sulfuric acid (H_2SO_4), a contributor to acid rain. Sulfuric acid also reacts with basic substances to give sulfates, which are fine particulates that contribute to PM-10 and visibility reduction.

6.2 EMISSION CONTROLS[14]

Caterpillar controls emissions by controlling combustion process. In all the proposed engine replacements, Caterpillar uses inlet air coolers (also referred to as an intercooler or aftercooler when used to cool compressed air charge from either a turbocharger or blower) to reduce the temperature of the intake air used in combustion to reduce the formation of thermal NOx emissions.

Caterpillar uses electronic controls to operate the natural gas fueled engines under lean air/fuel combustion conditions. Operation in the lean combustion range results in the lowest NOx emissions, with minimal CO and VOC emissions. Although CO and VOC emissions are lower under conditions just leaner than the stoichiometric ratio, emissions of these pollutants do not substantially increase under the leanest conditions. Operation under the leanest conditions results in a good compromise between dramatically reducing emissions of NOx and slightly increasing emissions of CO and VOC.

The Caterpillar Model G3608 engine is equipped with precombustion chambers. The engine uses a spark plug to ignite a small volume of near stoichiometric air/fuel mixture in a precombustion chamber. This combustion in the precombustion chamber rapidly expands through holes in the prechamber nozzle to ignite the very lean mixture in the main chamber or cylinder. The prechamber provides a high temperature, high speed ignition source for the combustion process which, overall is very lean (lambda>2.0). Effectively, the prechamber pushes out the lean limit observed for open chamber engines. Prechambers have the capability to operate at higher efficiency and lower NOx levels than open chamber engines. CO and HC levels will be somewhat higher than open chamber engines due to the larger quench (cool) zone around the cylinder wall.

To insure proper ignition, Caterpillar uses an Electronic Ignition System (EIS) on both the Model G3500 and G3600 series spark ignition natural gas engines to provide detonation protection and precision spark control for each cylinder. Detonation is controlled as it occurs and timing is retarded only as much and as long as necessary to prevent engine damage. The system consists of three basic groups: the control module, ignition transformers and sensors. The control module monitors engine operation through a series of sensors. The control module uses input from the sensors and the control panel settings to determine ignition timing. Detonation sensors (RHDS and LHDS) monitor the engine for excessive detonation (vibration). A speed/timing sensor provides accurate spark timing information for the control module. A manifold air pressure sensor provides engine load information to the EIS Control Module. The EIS system allows improved operation; economy, lower emission levels and also protects the engine from detonation and costly downtime, and maximizes power availability under adverse conditions.

Caterpillar's Industrial Air/Fuel Ratio Control System provides air/fuel ratio control (exhaust emissions control and performance tolerance to fuel BTU changes) and engine speed governing. Contains two subsystems, air-to-fuel ratio control and speed governing control that work together to maintain optimum engine operation throughout various operating conditions.

The Model G3608 is also fitted with Caterpillar's Engine Supervisory System (ESS). The ESS integrates several control systems installed on the engine. The ESS communicates with the Engine Control System that controls the air/fuel ratio, the ignition timing, and the limiting of power.
These electronic engine controls optimize engine operation by continually balancing power output, fuel economy and air/fuel ratio. While not specifically designed for emissions control, these controls work to maintain lean combustion conditions, which result in the lowest emissions, while maintaining a large operating range for the engines.

6.3 COMPLIANCE PROCEDURES

There are no specific compliance requirements for the natural gas fueled pump engines because there are no unit-specific limitations on emissions or operation. The diesel fueled generator is subject to an operating limit of 500 hours per year and NOx RACT emission limitation of 4.75 lb/million BTU. The engines are subject to the general visible emissions limitation of less than 20% opacity of Rule 62-296.320(4)(b), F.A.C.

7. SOURCE IMPACT ANALYSIS

An impact analysis was not required for this project because it is not subject to the requirements of PSD.

8. CONCLUSION

Based on the foregoing technical evaluation and other available information, a preliminary determination that the proposed project will comply with all applicable state and federal air pollution regulations. The Department will issue a draft permit to MDWASD that allows removal and replacement of the existing engine driven pumps #1 through #5 with a new diesel fueled engine driven generator and natural gas fuel engine driven pumps 3, 4 and 5.

The new engines will be subject to the requirements of the facility-wide specific conditions of Section II of the permit. The diesel fueled engine driven generator will be subject to an operating limit of 500 hours per year and NOx RACT emission limitation of 4.75 lb/million BTU, but the natural gas fueled pump engines will not be subject to any unit-specific emission limits. The natural gas fueled pump engines will be subject to an initial testing for NOx on two of the three engines.

This evaluation was prepared by:

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REFERENCES

[1] Provided by WASD at http://www.co.miami-dade.fl.us/wasd/about.htm.

[2] Application, April 2002.

[3] Information and photo from Caterpillar's promotional and technical information found at www.cat.com.

[4] Information and photo from Caterpillar's promotional and technical information found at www.cat.com.

[5] Information and photo from Caterpillar's promotional and technical information found at www.cat.com.

[6] Factor Information REtrieval (FIRE) Data System is a database containing EPA's recommended emission estimation factors for criteria and hazardous air pollutants.

[7] Source Classification Code, 20200401 is SCC for Internal Combustion Engines, Industrial, Large Bore Engine, Diesel

[8] Source Classification Code, 20200401 is SCC for Internal Combustion Engines, Industrial, Large Bore Engine, Diesel

[9] Source Classification Code, 20300201is SCC for Internal Combustion Engines, Commercial/Institutional, Natural Gas, Reciprocating

[10] Source Classification Code, 20300201is SCC for Internal Combustion Engines, Commercial/Institutional, Natural Gas, Reciprocating

[11] Florida Administrative Code 212.400-2

[12] Text of this section is adapted from *Compilation of Air Pollutant Emission Factors (AP- 42),* Volume I. Stationary Point and Area Sources, Chapter 3 Stationary Internal Combustion Sources, Fifth Edition.

[13] Excepted from Caterpillar Brochure LEKQ7261 *Gas Engines Application and Installation Guide G3600-G3300* © 1997 Caterpillar Inc.

[14] Information excerpted from Caterpillar product brochures, LEKQ7261, *Gas Engines Application and Installation Guide G3600-G3300* © 1997 Caterpillar Inc., LEKQ7257, *Gas Engines Application and Installation Guide G3500-G3300* © 1998 Caterpillar Inc., LEKQ7518, *G3500 Engine Basics, © 1999 Caterpillar Inc.,* and LEKQ9085, *G3600 Engine Basics, © 1999 Caterpillar Inc.*

PERMITTEE

Miami-Dade Water & Sewer Department
Alexander Orr, Jr. WTP

3071 SW 38th Avenue
Miami, Florida 33146-1520

Permit No.	0250314-005-AC
Project	Three Natural Gas Fueled Engine Driven Pump Sets
SIC No.	4941
Expires:	December 31, 2003

Authorized Representative:

Mr. Jorge S. Rodriguez, P.E.
Assistant Director – Water

PROJECT AND LOCATION

The permit authorizes Miami-Dade Water & Sewer Department to remove existing pumps and engines numbers 1 and 2, replacing the (pump/generator) capacity of engine number 1 with a diesel fueled engine driven emergency generator set and to replace existing diesel fueled engine driven pump numbers 3, 4 and 5 with three natural gas fueled engine driven pumps.

This facility is located at the Alexander Orr, Jr. Water Treatment Plant, 6800 SW 87 Avenue, Miami, Miami-Dade County. UTM coordinates are: Zone 17, 566.6 km E and 2843.5 km N.

STATEMENT OF BASIS

This construction permit is issued under the provisions of Chapter 403 of the Florida Statutes (F.S.), and the Florida Administrative Code (F.A.C.) Chapters 62-4, 62-204, 62-210, 62-212, 62-296, and 62-297. The above named permittee is authorized to perform the construction in accordance with the conditions of this permit and as described in the application, approved drawings, plans, and other documents on file with the Department of Environmental Protection (Department).

APPENDIX

The attached appendix is a part of this permit:

Appendix GC General Permit Conditions

Howard L. Rhodes, Director
Division of Air Resources
Management

FACILITY DESCRIPTION

This facility consists of a municipally owned water treatment plant providing potable water to the public.

PROJECT DETAILS

This permitting action is to remove existing pumps and engines numbers 1 and 2, replacing the (pump/generator) capacity of engine number 1 with a diesel fueled engine driven emergency generator set and to replace existing diesel fueled engine driven pump numbers 3, 4 and 5 with three natural gas fueled engine driven pumps. Emissions units that will be removed are 001 (engine and pump #1), 002 (engine and pump #2 which were previously removed from service), 003 (engine and pump #3), 004 (engine and pump #4), and 005 (engine and pump #5). Emissions units addressed by this permit are:

Emissions Unit No.	Emissions Unit Description
023[1]	1332 brake hp diesel fired Caterpillar Model 3508 TA-130, a 4-cycle turbocharged diesel internal combustion (IC) engine driving an electric generator prime rating 900 kW. Maximum heat input rate is 9.2 mmBtu/hr.
018[2]	810 brake hp natural gas fired Caterpillar Model G3512 LE-130 engine for pump 3. Maximum heat input rate is 6.00 mmBtu/hr. Pump has a designed 20 million gallons per day (MGD) water pumping capacity.
019[2]	810 brake hp natural gas fired Caterpillar Model G3512 LE-130 engine for pump 4. Maximum heat input rate is 6.00 mmBtu/hr. Pump has a designed 20 MGD water pumping capacity.
020[2]	2090 brake hp natural gas fired Caterpillar Model G3608 LE engine for pump 5. Maximum heat input rate is 13.70 mmBtu/hr. Pump has a designed 40 MGD water pumping capacity.

1 – New Emission Unit

2 – Previously Permitted Emission Units

REGULATORY CLASSIFICATION

This facility is classified as a Major or Title V Source of air pollution because emissions of at least one regulated air pollutant, such as particulate matter (PM/PM_{10}), sulfur dioxide (SO_2), nitrogen oxides (NOx), carbon monoxide (CO), or volatile organic compounds (VOC) exceeds 100 tons per year (TPY).

This facility is not within an industry included in the list of the 28 Major Facility Categories per Table 62-212.400-1, F.A.C. Because emissions are greater than 250 TPY for at least one criteria pollutant, the facility is also a Major Facility with respect to Rule 62-212.400, Prevention of Significant Deterioration (PSD).

This project is exempt from the requirements of Rule 62-212.400, F.A.C., Prevention of Significant Deterioration (PSD) as discussed in the Technical Evaluation and Preliminary Determination dated September 25, 2002.

The emission unit 023 in this project is subject to the Reasonable Available Control Technology (RACT) requirements of 62-296.570(4)(b)7 which limits the emissions of NOx to 4.75 lb/MMBtu from oil fired diesel generator.

The emissions units (18, 19 and 20) included in this project are not subject to any unit-specific emission limiting standard (considered "unregulated" for purposes of Title V permitting).

PERMIT SCHEDULE

- 05/13/02 Received application for construction permit
- 08/05/02 Permit application deemed complete
- 09/xx/02 Distributed Notice of Intent to Issue permit
- 10/xx/02 Notice of Intent published in _____

RELEVANT DOCUMENTS

The documents listed below are the basis of the permit. They are specifically related to this permitting action. These documents are on file with the Department.

- Application received at the Bureau of Air Regulation on May 13, 2002
- Department's letter dated June 10, 2002
- Applicant's response received August 5, 2002
- Department's Technical Evaluation and Preliminary Determination dated September 25, 2002
- Department's Intent to Issue and public notice information dated September xx, 2002

The following specific conditions apply to all emissions units at this facility addressed by this permit.

ADMINISTRATIVE

1. Regulating Agencies: All documents related to applications for permits to construct, operate or modify an emissions unit should be submitted to the Bureau of Air Regulation (BAR), Florida Department of Environmental Protection at Mail Station #5505, 2600 Blair Stone Road, Tallahassee, Florida 32399-2400, phone number 850/488-0114. All documents related to reports, tests, minor modifications and notifications shall be submitted to the Department's Southeast District office at PO Box 15425, West Palm Beach, Florida, 33416-5425, and phone number 561/681-6600. Copies of all documents should be sent also to the Air Quality Management Division, Miami-Dade County Department of Environmental Resources Management, Suite 900 33 SW Second Avenue, Miami, Florida 33130-1540.
2. General Conditions: The owner and operator is subject to and shall operate under the attached General Permit Conditions G.1 through G.15 listed in Appendix GC of this permit. General Permit Conditions are binding and enforceable pursuant to Chapter 403 of the Florida Statutes. [Rule 62-4.160, F.A.C.]
3. Terminology: The terms used in this permit have specific meanings as defined in the corresponding chapters of the Florida Administrative Code.
4. Applicable Regulations, Forms and Application Procedures: Unless otherwise indicated in this permit, the construction and operation of the subject emissions unit shall be in accordance with the capacities and specifications stated in the application. The facility is subject to all applicable provisions of Chapter 403, F.S. and Florida Administrative Code Chapters 62-4, 62-110, 62-204, 62-212, 62-213, 62-296, 62-297 and the Code of Federal Regulations Title 40, Part 60, adopted by reference in the Florida Administrative Code (F.A.C.) regulations. The permittee shall use the applicable forms listed in Rule 62-210.900, F.A.C. and follow the application procedures in Chapter 62-4, F.A.C. Issuance of this permit does not relieve the facility owner or operator from compliance with any applicable federal, state, or local permitting or regulations. [Rules 62-204.800, 62-210.300 and 62-210.900, F.A.C.]
5. New or Additional Conditions: Pursuant to Rule 62-4.080, F.A.C., for good cause shown and after notice and an administrative hearing, if requested, the Department may require the permittee to conform to new or additional conditions. The Department shall allow the permittee a reasonable time to conform to the new or additional conditions, and on application of the permittee, the Department may grant additional time. [Rule 62-4.080, F.A.C.]
6. Expiration: This air construction permit shall expire on **December 31, 2003**. The permittee, for good cause, may request that this construction permit be extended. Such a request shall be submitted to the Department's Bureau of Air Regulation prior to 60 days before the expiration of the permit. [Rules 62-210.300(1), 62-4.070(4), 62-4.080, and 62-4.210, F.A.C]
7. Modifications: No emissions unit or facility subject to this permit shall be constructed or modified without obtaining an air construction permit from the Department. Such permit must be obtained prior to the beginning of construction or modification. [Rules 62-210.300(1) and 62-212.300(1)(a), F.A.C.]
8. Title V Operation Permit Required: This permit authorizes construction and/or installation of the permitted emissions unit and initial operation to determine compliance with Department rules. A Title V operation permit is required for regular operation of the permitted emissions unit. The owner

or operator shall apply for and receive a Title V operation permit prior to expiration of this permit. To apply for a Title V operation permit, the applicant shall submit the appropriate application form, compliance test results, and such additional information as the Department may by law require. The application shall be submitted to the Department's Southeast District office. [Rules 62-4.030, 62-4.050, 62-4.220, and Chapter 62-213, F.A.C.]

EMISSION LIMITING STANDARDS

9. General Visible Emissions Standard: Except for emissions units that are subject to a particulate matter or opacity limit set forth or established by rule and reflected by conditions in this permit, no person shall cause, let, permit, suffer, or allow to be discharged into the atmosphere the emissions of air pollutants from any activity, the density if which is equal to or greater than that designated as Number 1 on the Ringelmann Chart (20% opacity). The test method for visible emissions shall be EPA Method 9, incorporated and adopted by reference in Chapter 62-297, F.A.C. Test procedures shall meet all applicable requirements of Chapter 62-297, F.A.C. [Rule 62-296.320(4)(b)1, F.A.C.]

10. General Pollutant Emission Limiting Standards: [Rule 62-296.320(2), F.A.C.]

    No person shall cause, suffer, allow or permit the discharge of air pollutants which cause or contribute to an objectionable odor.

    [Note: An objectionable odor is defined in Rule 62-210.200(198), F.A.C., as any odor present in the outdoor atmosphere which by itself or in combination with other odors, is or may be harmful or injurious to human health or welfare, which unreasonably interferes with the comfortable use and enjoyment of life or property, or which creates a nuisance.]

OPERATIONAL REQUIREMENTS

11. Plant Operation - Problems: If temporarily unable to comply with any of the conditions of the permit due to breakdown of equipment or destruction by hazard of fire, wind or by other cause, the permittee shall immediately notify the Department's district office and, if applicable, appropriate local program. The notification shall include pertinent information as to the cause of the problem, and what steps are being taken to correct the problem and to prevent its recurrence, and where applicable, the owner's intent toward reconstruction of destroyed facilities. Such notification does not release the permittee from any liability for failure to comply with Department rules. [Rule 62-4.130, F.A.C.]

12. Circumvention: No person shall circumvent any air pollution control device or allow the emission of air pollutants without the applicable air pollution control device operating properly. [Rule 62-210.650, F.A.C.]

13. Excess Emissions:

    (a) Excess emissions resulting from start-up, shutdown or malfunction of any emissions units shall be permitted providing (1) best operational practices to minimize emissions are adhered to and (2) the duration of excess emissions shall be minimized, but in no case exceed two hours in any 24 hour period unless specifically authorized by the Department for longer duration. [Rule 62-210.700(1), F.A.C.]

    (b) Excess emissions which are caused entirely or in part by poor maintenance, poor operation, or any other equipment or process failure which may reasonably be prevented during start-up, shutdown, or malfunction shall be prohibited. [Rule 62-210.700(4), F.A.C.]

COMPLIANCE MONITORING AND TESTING REQUIREMENTS

14. Required Number of Test Runs: For mass emission limitations, a compliance test shall consist of three complete and separate determinations of the total air pollutant emission rate through the test section of the stack or duct and three complete and separate determinations of any applicable process variables corresponding to the three distinct time periods during which the stack emission rate was measured; provided, however, that three complete and separate determinations shall not be required if the process variables are not subject to variation during a compliance test, or if three determinations are not necessary in order to calculate the unit's emission rate. The three required test runs shall be completed within one consecutive five-day period. In the event that sample is lost or one of the three runs must be discontinued because of circumstances beyond the control of the owner or operator, and a valid third run cannot be obtained within the five-day period allowed form the test, the Secretary or his or her designee may accept the results of two complete runs as proof of compliance, provided that the arithmetic mean of the two complete runs is at least 20 percent below the allowable emission limiting standards. [Rule 62-297.310(1), F.A.C.]

15. Operating Rate During Testing: Unless otherwise stated in the applicable emission limiting standard rule, testing of emission shall be conducted with the emission unit operation at permitted capacity. Permitted capacity is defined as 90 to 100 percent of the maximum operation rate allowed by the permit. If it is impractical to test at permitted capacity, an emission unit may be tested at less than the minimum permitted capacity; in this case, subsequent emission unit operation is limited to 110 percent of the test load until a new test is conducted. Once the unit is so limited, operation at higher capacities is allowed for no more than 15 consecutive days for the purpose of additional compliance testing to regain the authority to operate at the permitted capacity. [Rule 62-297.310(2), F.A.C.]

16. Calculation of Emission Rate: The indicated emission rate or concentration shall be the arithmetic average of the emission rate or concentration determined by each of the three separate test runs unless otherwise specified in a particular test method or applicable rule.

17. Test Procedures shall meet all applicable requirements of Rule 62-297.310(4), F.A.C. [Rule 62-297.310(4), F.A.C.]

18. Special Compliance Tests: When the Department, after investigation, has good reason (such as complaints, increased visible emissions or questionable maintenance of control equipment) to believe that any applicable emission standard contained in a Department rule or in a permit issued pursuant to those rules is being violated, it shall require the owner or operator of the facility to conduct compliance tests which identify the nature and quantity of pollutant emissions from the emissions units and to provide a report on the results of said tests to the Department. [Rule 62-297.310(7)(b), F.A.C.]

19. Determination of Process Variables.

(a) Required Equipment. The owner or operator of an emission unit for which compliance tests are required shall install, operate, and maintain equipment or instruments necessary to determine process variables, such as process weight input or heat input, when such data are needed in conjunction with emission data to determine the compliance of the emission unit with applicable emission limiting standards.

(b) Accuracy of Equipment: Equipment or instruments used to directly or indirectly determine process variables, including devices such as belt scales, weight hoppers, flow meters, and tank scales, shall be calibrated and adjusted to indicate the true value of the parameter being measured with sufficient accuracy to allow the applicable process variable to be determined within 10% of its true value. [Rule 62-297.310(5), F.A.C.]

20. Required Stack Sampling Facilities: Sampling facilities include sampling ports, work platforms, access to work platforms, electrical power, and sampling equipment support. All stack sampling facilities must meet any Occupational Safety and Health Administration (OSHA) Safety and Health Standards described in 29 CFR Part 1910, Subparts D and E. Sampling facilities shall also conform to the requirements of Rule 62-297.310(6), F.A.C. See Appendix SS-1, Stack Sampling Facilities. [Rule 62-297.310(6), F.A.C.]

REPORTING AND RECORD KEEPING REQUIREMENTS

21. Test Notification: The owner or operator shall notify the Department's Southeast District office, Air Program and, if applicable, appropriate local program, at least 15 days prior to the date on which each formal compliance test is to begin. Notification shall include the date, time, and place of each such test, and the test contact person who will be responsible for coordinating and having such test conducted for the owner or operator. [Rule 62-297.310(7)(a)9, F.A.C.]

22. Duration of Record Keeping: Upon request, the permittee shall furnish all records and plans required under Department rules. During enforcement actions, the retention period for all records will be extended automatically unless otherwise stipulated by the Department. The permittee shall hold at the facility or other location designated by this permit records of all monitoring information (including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation) required by the permit, copies of all reports required by this permit, and records of all data used to complete the application for this permit. These materials shall be retained at least five years from the date of the sample, measurement, report, or application unless otherwise specified by Department rule. [Rules 62-4.160(14)(a)&(b) and 62-213.440(1)(b)2.b., F.A.C.]

23. Test Reports: The owner or operator of an emission unit for which a compliance test is required shall file a report with the Department on the results of each such test. The required test report shall be filed with the Department as soon as practical but no later than 45 days after the last sampling run of each test is completed. The test report shall provide sufficient detail on the emission unit tested and the test procedures used to allow the Department to determine if the test was properly conducted and the test results properly computed. As a minimum, the test report, other than for an EPA or DEP Method 9 test, shall provide the applicable information listed in Rule 62-297.310(8)(c), F.A.C. [Rule 62-297.310(8), F.A.C.]

24. Excess Emissions Report: If excess emissions occur, the owner or operator shall notify the Department within one working day of: the nature, extent, and duration of the excess emissions; the cause of the excess emissions; and the actions taken to correct the problem. In addition, the Department may request a written summary report of the incident. Pursuant to the New Source Performance Standards, excess emissions shall also be reported in accordance with 40 CFR 60.7, Subpart A. [Rule 62-4.130, F.A.C.]

25. Excess Emissions Report - Malfunctions: In case of excess emissions resulting from malfunctions, each owner or operator shall notify the Department or the appropriate local program in accordance with Rule 62-4.130, F.A.C. A full written report on the malfunctions shall be submitted in a quarterly report if requested by the Department. [Rule 62-210.700(6), F.A.C.]

26. Annual Operating Report for Air Pollutant Emitting Facility: The Annual Operating Report for Air Pollutant Emitting Facility shall be completed each year and shall be submitted to the Department's Southeast District office and, if applicable, the appropriate local program by March 1 of the following year. [Rule 62-210.370(3), F.A.C.]

The following specific conditions apply to the following emission unit after construction:

Emissions Unit No.	Emissions Unit Description
023	1332 brake hp diesel fired Caterpillar Model 3508 TA-130, a 4-cycle turbocharged diesel internal combustion (IC) engine driving an electric generator prime rating 900 kW. Maximum heat input rate is 9.2 mmBtu/hr.

[Note: This emission unit is subject to the NOx RACT requirements of 62-296.570, F.A.C.]

OPERATIONAL REQUIREMENTS

1. Hours of Operation: The emission unit may operate for 500 hours/year. [Rule 62-210.200, F.A.C., Definitions-potential to emit (PTE)]
2. Fuel: The emission unit shall be fired with diesel fuel with a maximum sulfur content of 0.05 percent, by weight. Fuel consumption shall not exceed 33,250 gallons of diesel fuel in any consecutive 12-month period. The owner or operator shall keep monthly records of total fuel consumption for the emission unit. [Rule 62-210.200, F.A.C., Definitions-potential to emit (PTE)]
3. Operating Procedures: The emission unit shall be properly operated and maintained at all times in a condition to minimize emissions of air pollutants. The owner and operator shall ensure that all facility staff responsible for the emission unit is trained in the operation and maintenance in accordance with the guidelines and procedures as established by the equipment manufacturers. [Rule 62-4.070(3), F.A.C.]

EMISSION LIMITATIONS AND STANDARDS

4. Visible Emission: These emission units are subject to the General Visible Emission Standards. See condition 9 in Section II, Facility-Wide Specific Conditions. [Rule 62-296.320(4)(b), F.A.C.]
5. Nitrogen Oxides (NOx) Emission: Emission of NO_x shall not exceed 4.75 lb/MMBtu. [Rule 62-296.570(4)(b)7, F.A.C.]

COMPLIANCE MONITORING AND TESTING REQUIREMENTS

6. Visible Emission: Compliance with the visible emission limitation shall be determined each federal fiscal year (Oct.1-Sept.30) using EPA Method 9 contained in 40 CFR 60, Appendix A and adopted by reference in Rule 62-297, F.A.C. The minimum requirements for stationary point sources emission test procedures and reporting shall be in accordance with Rule 62-297, F.A.C. and 40 CFR 60 Appendix A. [Rule 62-297, F.A.C.]
7. Nitrogen Oxide (NOx) Emission Tests: Compliance with the emission limits for NOx of this permit shall be demonstrated each federal fiscal year (Oct.1-Sept. 30), if applicable, by using EPA Method 7 or 7E, as described in 40 CFR 60, Appendix A, adopted by reference in Rule 62-204.800, F.A.C., and adopted in Rule 62-297.401, F.A.C. Sampling of the exhaust gas shall be via a rake probe placed into the engine exhaust outlet. [Rules 62-4.070(3), 62-204.800, 62-297.310, and 62-297.401, F.A.C.]
8. Fuel Sulfur Content Tests: The owner or operator shall determine the sulfur content of each delivery of diesel fuel received for these emission units using ASTM D 4057-88, Standard Practice for

Manual Sampling of Petroleum and Petroleum Products and one of the following test methods for sulfur in petroleum products: ASTM D 129-91, ASTM D 2622-94, or ASTM D 4294-90. These methods are adopted by Rule 62-297.440, F.A.C. The owner or operator may comply with this requirement by receiving records from the fuel supplier that indicate the sulfur content of the fuel delivered complies with the sulfur limit of specific condition 2. [Rules 62-4.070(3), 62-297.440, F.A.C.]

9. Fuel Consumption: The owner or operator shall monitor fuel consumption by metering the fuel between the storage tank and the emission unit. [Rule 62-4.070(3), F.A.C.]

REPORTING AND RECORDKEEPING REQUIREMENTS

10. Meter Fuel Calibration: Calibration of the fuel meter shall be conducted in accordance with manufacturer's schedule and recommendation. [Rule 62-4.070(3), F.A.C.]

11. Fuel Sulfur Content Records: The owner or operator shall maintain records of sulfur content of each delivery of diesel fuel received for the emission unit. [Rule 62-4.070(3), F.A.C.]

12. Records of Maintenance: The owner or operator shall make and maintain records of maintenance sufficient to demonstrate compliance with the operating procedure requirements of specific condition 3 of this permit. [Rule 62-4.070(3), F.A.C.]

The following specific conditions apply to the following emissions units after construction:

Emissions Unit No.	Emissions Unit Description
018	810 brake hp natural gas fired Caterpillar Model G3512 LE-130 engine for pump 3. Maximum heat input rate is 6.00 mmBtu/hr. Pump has a designed 20 million gallons per day (MGD) water pumping capacity.
019	810 brake hp natural gas fired Caterpillar Model G3512 LE-130 engine for pump 4. Maximum heat input rate is 6.00 mmBtu/hr. Pump has a designed 20 MGD water pumping capacity.
020	2090 brake hp natural gas fired Caterpillar Model G3608 LE engine for pump 5. Maximum heat input rate is 13.70 mmBtu/hr. Pump has a designed 40 MGD water pumping capacity.

Note: These emissions units are not subject to any unit-specific applicable requirements. They are subject to the requirements of Section II, Facility-Wide Specific Conditions, of this permit. This permit was written to authorize removal of emissions units 003 through 005 and installation of these emissions units. The Waukesha units permitted in 1999 (0250314-003-AC) were not installed and are being replaced by the Caterpillar units. However, uncontrolled potential emissions are not significantly greater than past actual emissions for purposes of PSD. The Department is requiring initial tests for NOx emissions on both Unit No. 18 or 19 and Unit No. 20 for demonstration purposes only.

OPERATIONAL REQUIREMENTS

1. Hours of Operation: These emissions units may operate continuously, i.e., 8,760 hours/year. [Rule 62-210.200, F.A.C., Definitions-potential to emit (PTE)]
2. Fuel: The emission unit shall be fired with natural gas. Fuel consumption shall not exceed 88 million standard cubic feet (MMscf) in any consecutive 12-month period for Units 018 and 019 combined. Annual fuel consumption shall not exceed 111 MMscf in any consecutive 12-month period for Unit 020. The owner or operator shall keep monthly records of total fuel consumption for these emissions units. [Rule 62-210.200, F.A.C., Definitions-potential to emit (PTE)]
3. Operating Procedures: The emission unit shall be properly operated and maintained at all times in a condition to minimize emissions of air pollutants. The owner and operator shall ensure that all facility staff responsible for the emission unit is trained in the operation and maintenance in accordance with the guidelines and procedures as established by the equipment manufacturers. [Rule 62-4.070(3), F.A.C.]
4. Nitrogen Oxide (NOx) Initial Emission Tests: Initial NOx emissions tests shall be conducted on either Unit No. 18 or 19 and Unit No. 20. NOx emissions from Unit No. 18 or 19 shall not exceed 4.4 lb/hr. NOx emissions from Unit No. 20 shall not exceed 3.2 lb/hr. NOx emissions shall be demonstrated by using EPA Method 7 or 7E, as described in 40 CFR 60, Appendix A, adopted by reference in Rule 62-204.800, F.A.C., and adopted in Rule 62-297.401, F.A.C. Sampling of the exhaust gas shall be via a rake probe placed into the engine exhaust outlet. Test report shall be submitted to the Bureau of Air Regulation in Tallahassee. [Rule 62-210.200, F.A.C., Definitions-potential to emit (PTE)]

G.1 The terms, conditions, requirements, limitations, and restrictions set forth in this permit are "Permit Conditions" and are binding and enforceable pursuant to Sections 403.161, 403.727, or 403.859 through 403.861, Florida Statutes. The permittee is placed on notice that the Department will review this permit periodically and may initiate enforcement action for any violation of these conditions.

G.2 This permit is valid only for the specific processes and operations applied for and indicated in the approved drawings or exhibits. Any unauthorized deviation from the approved drawings or exhibits, specifications, or conditions of this permit may constitute grounds for revocation and enforcement action by the Department.

G.3 As provided in Subsections 403.087(6) and 403.722(5), Florida Statutes, the issuance of this permit does not convey and vested rights or any exclusive privileges. Neither does it authorize any injury to public or private property or any invasion of personal rights, nor any infringement of federal, state or local laws or regulations. This permit is not a waiver or approval of any other Department permit that may be required for other aspects of the total project which are not addressed in the permit.

G.4 This permit conveys no title to land or water, does not constitute State recognition or acknowledgment of title, and does not constitute authority for the use of submerged lands unless herein provided and the necessary title or leasehold interests have been obtained from the State. Only the Trustees of the Internal Improvement Trust Fund may express State opinion as to title.

G.5 This permit does not relieve the permittee from liability for harm or injury to human health or welfare, animal, or plant life, or property caused by the construction or operation of this permitted source, or from penalties therefore; nor does it allow the permittee to cause pollution in contravention of Florida Statutes and Department rules, unless specifically authorized by an order from the Department.

G.6 The permittee shall properly operate and maintain the facility and systems of treatment and control (and related appurtenances) that are installed or used by the permittee to achieve compliance with the conditions of this permit, as required by Department rules. This provision includes the operation of backup or auxiliary facilities or similar systems when necessary to achieve compliance with the conditions of the permit and when required by Department rules.

G.7 The permittee, by accepting this permit, specifically agrees to allow authorized Department personnel, upon presentation of credentials or other documents as may be required by law and at a reasonable time, access to the premises, where the permitted activity is located or conducted to:

(a) Have access to and copy and records that must be kept under the conditions of the permit;
(b) Inspect the facility, equipment, practices, or operations regulated or required under this permit, and,
(c) Sample or monitor any substances or parameters at any location reasonably necessary to assure compliance with this permit or Department rules.

Reasonable time may depend on the nature of the concern being investigated.

G.8 If, for any reason, the permittee does not comply with or will be unable to comply with any condition or limitation specified in this permit, the permittee shall immediately provide the Department with the following information:

(a) A description of and cause of non-compliance; and
(b) The period of noncompliance, including dates and times; or, if not corrected, the anticipated time the non-compliance is expected to continue, and steps being taken to reduce, eliminate, and prevent recurrence of the non-compliance.

The permittee shall be responsible for any and all damages which may result and may be subject to enforcement action by the Department for penalties or for revocation of this permit.

G.9 In accepting this permit, the permittee understands and agrees that all records, notes, monitoring data and other information relating to the construction or operation of this permitted source which are submitted to the Department may be used by the Department as evidence in any enforcement case involving the permitted source arising under the Florida Statutes or Department rules, except where such use is prescribed by Sections 403.73 and 403.111, Florida Statutes. Such evidence shall only be used to the extend it is consistent with the Florida Rules of Civil Procedure and appropriate evidentiary rules.

G.10 The permittee agrees to comply with changes in Department rules and Florida Statutes after a reasonable time for compliance, provided, however, the permittee does not waive any other rights granted by Florida Statutes or Department rules.

G.11 This permit is transferable only upon Department approval in accordance with Florida Administrative Code Rules 62-4.120 and 62-730.300, F.A.C., as applicable. The permittee shall be liable for any non-compliance of the permitted activity until the transfer is approved by the Department.

G.12 This permit or a copy thereof shall be kept at the work site of the permitted activity.

G.13 This permit also constitutes:

(a) Determination of Best Available Control Technology ( );
(b) Determination of Prevention of Significant Deterioration ( ); and
(c) Compliance with New Source Performance Standards ( ).

G.14 The permittee shall comply with the following:

(a) Upon request, the permittee shall furnish all records and plans required under Department rules. During enforcement actions, the retention period for all records will be extended automatically unless otherwise stipulated by the Department.
(b) The permittee shall hold at the facility or other location designated by this permit records of all monitoring information (including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation) required by the permit, copies of all reports required by this permit, and records of all data used to complete the application or this permit. These materials shall be retained at least three years from the date of the sample, measurement, report, or application unless otherwise specified by Department rule.
(c) Records of monitoring information shall include:

1. The date, exact place, and time of sampling or measurements;
2. The person responsible for performing the sampling or measurements;
3. The dates analyses were performed;
4. The person responsible for performing the analyses;
5. The analytical techniques or methods used; and
6. The results of such analyses.

G.15 When requested by the Department, the permittee shall within a reasonable time furnish any information required by law which is needed to determine compliance with the permit. If the permittee becomes aware that relevant facts were not submitted or were incorrect in the permit application or in any report to the Department, such facts or information shall be corrected promptly.

Memorandum

Florida Department of
Environmental Protection

TO: Al Linero

FROM: Syed Arif Syed Arif 9/24

DATE: September 24, 2002

SUBJECT: Miami-Dade Water & Sewer Department
Alexander Orr, Jr. WTP
Three Natural Gas Fueled Engine Driven Pump Sets & One Diesel Fueled Standby Generator

Attached for approval and signature is the construction permit for MDWASD's Alexander Orr, Jr. Water Treatment Plant. The permit is to remove existing pumps and engines numbers 1 and 2, replacing the (pump/generator) capacity of engine number 1 with a diesel fueled engine driven emergency generator set and to replace existing diesel fueled engine driven pump numbers 3, 4 and 5 with three natural gas fueled engine driven pumps.

The existing pump engines are fuel oil fired. The replacement engines have significantly lower air pollutant emissions per unit of work. The replacement emergency generator is restricted to 500 hours of operation annually. This restriction will keep nitrogen oxides emissions below the PSD significance levels. With the exception of carbon monoxide, potential emissions from the new engines are not expected to significantly increase compared to the past actual emissions of the existing engines. Carbon monoxide emissions do not increase above the PSD significance levels. An air quality impact analysis was not required or conducted.

The original permitting was done in 1999. The units proposed in the previous permit were not installed, the emission increment was not consumed and this project replaces the previous one.

September 24 is Day 50 of the project.

I recommend your approval and signature.

Attachments

/sa

Department of Environmental Protection

Jeb Bush
Governor

Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

David B. Struhs
Secretary

P.E. Certification Statement

Miami-Dade Water & Sewer Department
Alexander Orr, Jr. WTP
Three Natural Gas Fueled Engine Driven Pump Sets
and One Diesel Fueled Standby Generator

DEP File No.: 0250314-005-AC
Facility ID No.: 0250314

Project: Air Construction Permit

I HEREBY CERTIFY that the engineering features described in the above referenced application and related additional information submittals, if any, and subject to the proposed permit conditions, provide reasonable assurance of compliance with applicable provisions of Chapter 403, Florida Statutes, and Florida Administrative Code Chapters 62-4 and 62-204 through 62-297. However, I have not evaluated and I do not certify aspects of the proposal outside of my area of expertise (including but not limited to the electrical, mechanical, structural, hydrological, and geological features).

I conducted this review.

(Seal)

Syed Arif, P.E.
Registration Number: 51861

9/24/02
Date

Permitting Authority:
Florida Department of Environmental Protection
Division of Air Resources Management
Bureau of Air Regulation
New Source Review Section
Mail Station #5505
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Telephone: 850/921-9528
Fax: 850/922-6979

Application for Air Construction Permit for the

Replacement of Four Existing Diesel Fueled Engine Driven Pumps and Generator

Alexander Orr, Jr. Water Treatment Plant Miami, Florida

Miami-Dade Water and Sewer Department

April 2002

Background Photo Courtesy of the National Weather Service

SERVE • CONSERVE

MIAMI-DADE WATER AND SEWER DEPARTMENT
4200 Salzedo Street, Coral Gables, Florida 33146 • Tel: 305-669-3700 • Fax: 669-3788

May 3, 2002

Certified Mail: 7001 0360 0001 6782 7899
Return Receipt

Mr. Alvaro Linero, P.E.
Administrator
New Source Review Section
Florida Department of Environmental Protection
2600 Blair Stone Road
Tallahassee, FL 32399-2400

Subject: Application for Air Construction Permit for Three Natural Gas Fueled Engine Driven Pump Sets and One Diesel Fueled Engine Driven Standby Generator at the Alexander Orr, Jr. Water Treatment Plant, Miami, Florida - Facility ID No. 0250314

Dear Mr. Linero:

Enclosed, please find an application to obtain an air construction permit for the replacement of five diesel fueled engine driven pump sets with three natural gas fueled engine driven pump sets and one diesel fueled standby generator at the subject facility. The facility is operating under permit numbers 0250314-001-AC, PSD-FL-249. This application replaces the proposed construction previously permitted under DEP File No. 0250314-003-AC and includes:

1) One (1) signed and sealed filled application.
2) Three (3) additional signed and sealed signature pages.
3) Four (4) copies of the application in an electronic format.

As the designated Responsible Official of this facility, I certify this application to be true, accurate, and complete based upon information and belief formed after reasonable inquiry. Please contact me at (786) 552-8112 or Mr. Richard M. O'Rourke, P.E. at (786) 552-8123 if there are any questions regarding this submittal.

Sincerely,

Jorge S. Rodriguez, P.E
Assistant Director Water

JSR/BMG/RMO/ro

c: Gracy Danois, EPA Region 4 (w/o encl.)
Tom Tittle, FDEP/SED
Mallika Muthiah, M-D/DERM (w/o encl.)
Gregory F. Galmin, Poole & Kent

L0225dep.doc

Department of
Environmental Protection

Division of Air Resources Management

APPLICATION FOR AIR PERMIT - TITLE V SOURCE

See Instructions for Form No. 62-210.900(1)

I. APPLICATION INFORMATION

Identification of Facility

1. Facility Owner/Company Name: Miami-Dade Water and Sewer Department	
2. Site Name: Alexander Orr, Jr. Water Treatment Plant	
3. Facility Identification Number: 0250314	[ ] Unknown
4. Facility Location: Street Address or Other Locator: 6800 S.W. 87th Avenue City: Miami County: Miami Dade Zip Code: 33133-0316	
5. Relocatable Facility? [ ] Yes [X] No	6. Existing Permitted Facility? [X] Yes [ ] No

Application Contact

1. Name and Title of Application Contact: Richard M. O'Rourke, P.E.		
2. Application Contact Mailing Address: Organization/Firm: Miami-Dade Water & Sewer Street Address: P. O. Box 330316, 3071 SW 38th Avenue City: Miami	State: FL	Zip Code: 33233-0316
3. Application Contact Telephone Numbers: Telephone: (786) 552 - 8123	Fax: (786) 552 - 8640	

Application Processing Information (DEP Use)

1. Date of Receipt of Application:	5/13/02
2. Permit Number:	1250314-005-AC
3. PSD Number (if applicable):	
4. Siting Number (if applicable):	

Purpose of Application

Air Operation Permit Application

This Application for Air Permit is submitted to obtain: (Check one)

[ ] Initial Title V air operation permit for an existing facility which is classified as a Title V source.

[ ] Initial Title V air operation permit for a facility which, upon start up of one or more newly constructed or modified emissions units addressed in this application, would become classified as a Title V source.

Current construction permit number:_____

[ ] Title V air operation permit revision to address one or more newly constructed or modified emissions units addressed in this application.

Current construction permit number:_____

Operation permit number to be revised:_____

[X] Title V air operation permit revision or administrative correction to address one or more proposed new or modified emissions units and to be processed concurrently with the air construction permit application. (Also check Air Construction Permit Application below.)

Operation permit number to be revised/corrected: 0250314-001-AV

[ ] Title V air operation permit revision for reasons other than construction or modification of an emissions unit.

Operation permit number to be revised:

Reason for revision:

Air Construction Permit Application

This Application for Air Permit is submitted to obtain: (Check one)

[X] Air construction permit to construct or modify one or more emissions units.

[ ] Air construction permit to make federally enforceable an assumed restriction on the potential emissions of one or more existing, permitted emissions units.

[ ] Air construction permit for one or more existing, but unpermitted, emissions units.

Owner/Authorized Representative or Responsible Official

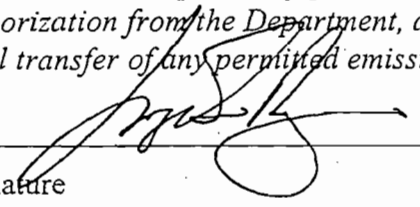
1. Name and Title of Owner/Authorized Representative or Responsible Official:
   Jorge S. Rodriguez, P.E., Assistant Director - Water

2. Owner/Authorized Representative or Responsible Official Mailing Address:
   Organization/Firm: Miami-Dade Water and Sewer Department
   Street Address: 3071 SW 38th Avenue
   City: Miami State: FL Zip Code: 33146-1520

3. Owner/Authorized Representative or Responsible Official Telephone Numbers:
   Telephone: (786) 552 - 8112 Fax: (786) 552 - 8626

4. Owner/Authorized Representative or Responsible Official Statement:

   I, the undersigned, am the owner or authorized representative(check here [X], if so) or the responsible official (check here [X], if so) of the Title V source addressed in this application, whichever is applicable. I hereby certify, based on information and belief formed after reasonable inquiry, that the statements made in this application are true, accurate and complete and that, to the best of my knowledge, any estimates of emissions reported in this application are based upon reasonable techniques for calculating emissions. The air pollutant emissions units and air pollution control equipment described in this application will be operated and maintained so as to comply with all applicable standards for control of air pollutant emissions found in the statutes of the State of Florida and rules of the Department of Environmental Protection and revisions thereof. I understand that a permit, if granted by the Department, cannot be transferred without authorization from the Department, and I will promptly notify the Department upon sale or legal transfer of any permitted emissions unit.*



Signature

5/3/10

Date

* Attach letter of authorization if not currently on file.

Professional Engineer Certification

1. Professional Engineer Name: Richard M. O'Rourke, P.E.
   Registration Number: 42683

2. Professional Engineer Mailing Address:
   Organization/Firm: Miami-Dade Water & Sewer
   Street Address: 3071 SW 38th Avenue
   City: Miami State: FL Zip Code: 33146-1520

3. Professional Engineer Telephone Numbers:
   Telephone: (786) 552 - 8123 Fax: (786) 552 - 8640

4. Professional Engineer Statement:

I, the undersigned, hereby certify, except as particularly noted herein, that:*

(1) To the best of my knowledge, there is reasonable assurance that the air pollutant emissions unit(s) and the air pollution control equipment described in this Application for Air Permit, when properly operated and maintained, will comply with all applicable standards for control of air pollutant emissions found in the Florida Statutes and rules of the Department of Environmental Protection; and

(2) To the best of my knowledge, any emission estimates reported or relied on in this application are true, accurate, and complete and are either based upon reasonable techniques available for calculating emissions or, for emission estimates of hazardous air pollutants not regulated for an emissions unit addressed in this application, based solely upon the materials, information and calculations submitted with this application.

If the purpose of this application is to obtain a Title V source air operation permit (check here [ ], if so), I further certify that each emissions unit described in this Application for Air Permit, when properly operated and maintained, will comply with the applicable requirements identified in this application to which the unit is subject, except those emissions units for which a compliance schedule is submitted with this application.

If the purpose of this application is to obtain an air construction permit for one or more proposed new or modified emissions units (check here [X], if so), I further certify that the engineering features of each such emissions unit described in this application have been designed or examined by me or individuals under my direct supervision and found to be in conformity with sound engineering principles applicable to the control of emissions of the air pollutants characterized in this application.

If the purpose of this application is to obtain an initial air operation permit or operation permit revision for one or more newly constructed or modified emissions units (check here [X], if so), I further certify that, with the exception of any changes detailed as part of this application, each such emissions unit has been constructed or modified in substantial accordance with the information given in the corresponding application for air construction permit and with all provisions contained in such permit.

Signature 42683 Date 29 APRIL 2002

(seal)

* Attach any exception to certification statement.

Owner/Authorized Representative or Responsible Official

1. Name and Title of Owner/Authorized Representative or Responsible Official:
   Jorge S. Rodriguez, P.E., Assistant Director - Water

2. Owner/Authorized Representative or Responsible Official Mailing Address:
   Organization/Firm: Miami-Dade Water and Sewer Department
   Street Address: 3071 SW 38th Avenue
   City: Miami State: FL Zip Code: 33146-1520

3. Owner/Authorized Representative or Responsible Official Telephone Numbers:
   Telephone: (786) 552 - 8112 Fax: (786) 552 - 8626

4. Owner/Authorized Representative or Responsible Official Statement:

   I, the undersigned, am the owner or authorized representative(check here [X], if so) or the responsible official (check here [X], if so) of the Title V source addressed in this application, whichever is applicable. I hereby certify, based on information and belief formed after reasonable inquiry, that the statements made in this application are true, accurate and complete and that, to the best of my knowledge, any estimates of emissions reported in this application are based upon reasonable techniques for calculating emissions. The air pollutant emissions units and air pollution control equipment described in this application will be operated and maintained so as to comply with all applicable standards for control of air pollutant emissions found in the statutes of the State of Florida and rules of the Department of Environmental Protection and revisions thereof. I understand that a permit, if granted by the Department, cannot be transferred without authorization from the Department, and I will promptly notify the Department upon sale or legal transfer of any permitted emissions unit.*

   Signature 5/3/12
   Date

* Attach letter of authorization if not currently on file.

Professional Engineer Certification

1. Professional Engineer Name: Richard M. O'Rourke, P.E.
   Registration Number: 42683

2. Professional Engineer Mailing Address:
   Organization/Firm: Miami-Dade Water & Sewer
   Street Address: 3071 SW 38th Avenue
   City: Miami State: FL Zip Code: 33146-1520

3. Professional Engineer Telephone Numbers:
   Telephone: (786) 552 - 8123 Fax: (786) 552 - 8640

4. Professional Engineer Statement:

I, the undersigned, hereby certify, except as particularly noted herein, that:*

(1) To the best of my knowledge, there is reasonable assurance that the air pollutant emissions unit(s) and the air pollution control equipment described in this Application for Air Permit, when properly operated and maintained, will comply with all applicable standards for control of air pollutant emissions found in the Florida Statutes and rules of the Department of Environmental Protection; and

(2) To the best of my knowledge, any emission estimates reported or relied on in this application are true, accurate, and complete and are either based upon reasonable techniques available for calculating emissions or, for emission estimates of hazardous air pollutants not regulated for an emissions unit addressed in this application, based solely upon the materials, information and calculations submitted with this application.

If the purpose of this application is to obtain a Title V source air operation permit (check here [ ], if so), I further certify that each emissions unit described in this Application for Air Permit, when properly operated and maintained, will comply with the applicable requirements identified in this application to which the unit is subject, except those emissions units for which a compliance schedule is submitted with this application.

If the purpose of this application is to obtain an air construction permit for one or more proposed new or modified emissions units (check here [X], if so), I further certify that the engineering features of each such emissions unit described in this application have been designed or examined by me or individuals under my direct supervision and found to be in conformity with sound engineering principles applicable to the control of emissions of the air pollutants characterized in this application.

If the purpose of this application is to obtain an initial air operation permit or operation permit revision for one or more newly constructed or modified emissions units (check here [X], if so), I further certify that, with the exception of any changes detailed as part of this application, each such emissions unit has been constructed or modified in substantial accordance with the information given in the corresponding application for air construction permit and with all provisions contained in such permit.

Signature 42683 Date 29 April 2002

(seal)

* Attach any exception to certification statement.

Scope of Application

Emissions Unit ID	Description of Emissions Unit	Permit Type	Processing Fee
1	Pump Engine Nos. 3, 4 (Natural Gas)	ACM1	$ 0.00
2	Pump Engine No. 5 (Natural Gas)	ACM1	$ 0.00
3	Pump Room Emergency Generator	ACM1	$ 0.00

Application Processing Fee

Check one: [ ] Attached - Amount: $_____ [**X**] Not Applicable

Construction/Modification Information

1. Description of Proposed Project or Alterations:

This application replaces the proposed construction previously permitted under DEP File No. 0250314-003-AC. This application is for a new construction permit to remove and replace existing diesel fueled engine driven pumps and generator nos. 1, 2, 3, 4, & 5.

Natural gas fueled engine driven pumps No.3 (810 bhp), No.4 (810 bhp) & No. 5 (2225 bhp) are proposed as replacements. The two (2) 810 bhp engines are proposed as a single, collectively regulated emissions unit. The 2225 bhp engine is proposed in this application as a single regulated emissions unit.

A 1332 bhp (1220 bhp continuous) diesel fueled engine driven 900 KW (810KW continuous) generator set is proposed to replace the 750 KW emergency generator that engine no. 1 also drove.

2. Projected or Actual Date of Commencement of Construction: 3/1/2000

3. Projected Date of Completion of Construction: 12/31/2002

Application Comment

This application replaces the proposed construction previously permitted under DEP File No. 0250314-003-AC. The purpose of this application is to obtain construction permits to remove existing pumps & engines no. 1 and 2, replacing the (pump/generator) capacity of engine no. 1 with a diesel fueled engine driven emergency generator set and to replace existing diesel fueled engine driven pump nos. 3, 4 & 5 with three natural gas fueled engine driven pumps.

The existing units operate without restrictions. A two-year period from April 1998 to March 2000 was used to calculate the existing emissions because it was the last period in which all units (except no. 2 out of service) were operated.

The replacement emergency generator has the potential to emit over 160 tons of NOx annually when operated continuously, however this application proposes to restrict operation to only 500 hours or 33,250 gallons of fuel annually. A comparison of past actual emissions to proposed emissions with the proposed operational restrictions result in a net annual increase of 15.27 ton of NOx, 66.23 tons of CO, 0.07 tons of PM, 4.37 tons of PM10, 0.15 tons of SOx and 11.66 tons of VOC.

Information included in this construction permit application should be assimilated into the existing Title V operating permit

II. FACILITY INFORMATION

A. GENERAL FACILITY INFORMATION

Facility Location and Type

1. Facility UTM Coordinates: Zone: 17	East (km): 566.60		North (km): 2843.50
2. Facility Latitude/Longitude: Latitude (DD/MM/SS): 25 / 42 / 30		Longitude (DD/MM/SS): 80 / 20 / 10	
3. Governmental Facility Code: 3	4. Facility Status Code: A	5. Facility Major Group SIC Code: 49	6. Facility SIC(s): 4941

7. Facility Comment (limit to 500 characters):

Facility treats up to 241.7 million gallons a day & up to 74,136 MG annually of raw water using a lime softening, filtration, recarbonation & disinfection for public water supply. Six standby generators provide standby electrical power required by the FDOH, for continuous plant operations. Engines driven pump sets are used to maintain pressure & convey water. A rotary kiln recovers the water softening process solids for conversion back in to quick lime for process reuse on site.

Facility Contact

1. Name and Title of Facility Contact: Tom Segars, Superintendent of Water Production			
2. Facility Contact Mailing Address: Organization/Firm: Miami-Dade Water and Sewer Department Street Address: 700 W. Second Ave. City: Hialeah	State: FL	Zip Code: 33010-0006(	
3. Facility Contact Telephone Numbers: Telephone: (305) 888 - 2522	Fax: (305) 889 - 0156		

Facility Regulatory Classifications

Check all that apply:

1. [ ] Small Business Stationary Source? [ ] Unknown
2. [X] Major Source of Pollutants Other than Hazardous Air Pollutants (HAPs)?
3. [ ] Synthetic Minor Source of Pollutants Other than HAPs?
4. [ ] Major Source of Hazardous Air Pollutants (HAPs)?
5. [ ] Synthetic Minor Source of HAPs?
6. [ ] One or More Emissions Units Subject to NSPS?
7. [ ] One or More Emission Units Subject to NESHAP?
8. [X] Title V Source by EPA Designation?
9. Facility Regulatory Classifications Comment (limit to 200 characters): Facility is a Publicly Owned Water Treatment and Water Supply Facility. This facility treats ground water using lime softening, filtration, recarbonation & disinfection for public water supply. The facility is a Title V source of regulated air pollutants other than hazardous air pollutants.

List of Applicable Regulations

Chapter 62-204.240, FAC: "Ambient Air Quality Standards"	
62-296.320, FAC: "General Pollutant Emissions Limiting Standards"	
Title V Core List except: 40 CFR 61; 40 CFR 82; 62-256, 62-257, 62-281, 62-296.320	

B. FACILITY POLLUTANTS

List of Pollutants Emitted

1. Pollutant Emitted	2. Pollutant Classif.	3. Requested Emissions Cap lb/hour	tons/year	4. Basis for Emissions Cap	5. Pollutant Comment
NOX	A				No Facility Cap Requested
CO	SM				No Facility Cap Requested
PM	B				No Facility Cap Requested
SO2	SM				No Facility Cap Requested

C. FACILITY SUPPLEMENTAL INFORMATION

Supplemental Requirements

1. Area Map Showing Facility Location:
   [X] Attached, Document ID: A01 [ ] Not Applicable [ ] Waiver Requested

2. Facility Plot Plan:
   [X] Attached, Document ID: A02 [ ] Not Applicable [ ] Waiver Requested

3. Process Flow Diagram(s):
   [ ] Attached, Document ID: _____ [X] Not Applicable [ ] Waiver Requested

4. Precautions to Prevent Emissions of Unconfined Particulate Matter:
   [ ] Attached, Document ID: _____ [X] Not Applicable [ ] Waiver Requested

5. Fugitive Emissions Identification:
   [ ] Attached, Document ID: _____ [X] Not Applicable [ ] Waiver Requested

6. Supplemental Information for Construction Permit Application:
   [X] Attached, Document ID: A03 [ ] Not Applicable

7. Supplemental Requirements Comment:

The Alexander Orr, Jr. WTP is a major source of air pollution and has a Title V operating permit no. 0250314-001-AV. (Chapter 62-213, FAC).

This application replaces the previously proposed construction permitted under DEP File No. 0250314-003-AC. This application requests a construction permit to replace existing sources. General Preconstruction Review applies to the new construction (Chapter 62-212.300, FAC).

Additional Supplemental Requirements for Title V Air Operation Permit Applications

8. List of Proposed Insignificant Activities:
   [ ] Attached, Document ID:_____ [X] Not Applicable

9. List of Equipment/Activities Regulated under Title VI:
   [ ] Attached, Document ID:_____
   [ ] Equipment/Activities On site but Not Required to be Individually Listed
   [X] Not Applicable

10. Alternative Methods of Operation:
    [ ] Attached, Document ID:_____ [X] Not Applicable

11. Alternative Modes of Operation (Emissions Trading):
    [ ] Attached, Document ID:_____ [X] Not Applicable

12. Identification of Additional Applicable Requirements:
    [ ] Attached, Document ID:_____ [X] Not Applicable

13. Risk Management Plan Verification:
    [X] Plan previously submitted to Chemical Emergency Preparedness and Prevention Office (CEPPO). Verification of submittal attached (Document ID: 7519) or previously submitted to DEP (Date and DEP Office:_____)
    [ ] Plan to be submitted to CEPPO (Date required:_____)
    [ ] Not Applicable

14. Compliance Report and Plan:
    [ ] Attached, Document ID:_____ [X] Not Applicable

15. Compliance Certification (Hard-copy Required):
    [ ] Attached, Document ID:_____ [X] Not Applicable

III. EMISSIONS UNIT INFORMATION

A separate Emissions Unit Information Section (including subsections A through J as required) must be completed for each emissions unit addressed in this Application for Air Permit. If submitting the application form in hard copy, indicate, in the space provided at the top of each page, the number of this Emissions Unit Information Section and the total number of Emissions Unit Information Sections submitted as part of this application.

A. GENERAL EMISSIONS UNIT INFORMATION
(All Emissions Units)

Emissions Unit Description and Status

1. Type of Emissions Unit Addressed in This Section: (Check one)

[ ] This Emissions Unit Information Section addresses, as a single emissions unit, a single process or production unit, or activity, which produces one or more air pollutants and which has at least one definable emission point (stack or vent).

[X] This Emissions Unit Information Section addresses, as a single emissions unit, a group of process or production units and activities which has at least one definable emission point (stack or vent) but may also produce fugitive emissions.

[ ] This Emissions Unit Information Section addresses, as a single emissions unit, one or more process or production units and activities which produce fugitive emissions only.

2. Regulated or Unregulated Emissions Unit? (Check one)

[ ] The emissions unit addressed in this Emissions Unit Information Section is a regulated emissions unit.

[X] The emissions unit addressed in this Emissions Unit Information Section is an unregulated emissions unit.

3. Description of Emissions Unit Addressed in This Section (limit to 60 characters):
Pump Engine Nos. 3, 4 (Natural Gas)

4. Emissions Unit Identification Number:
ID:
[X] No ID
[ ] ID Unknown

5. Emissions Unit Status Code:	6. Initial Startup Date:	7. Emissions Unit Major Group SIC Code:	8. Acid Rain Unit?
C		49	[N]

9. Emissions Unit Comment: (Limit to 500 Characters)
Pump engine nos. 2, 3 & 4 (E.U. ID Nos. 002-004) began service in August 1951 will be replaced by these new units. Permit 0250314-003-AC authorized replacement of these units with 738 bhp natural gas fired Waukesau Model 3521GL engines with a maximum heat input rate of 5.44 mmBtu/hr. This is to replace units with 810 bhp natural gas fired Caterpillar Model G3512 engines with a maximum heat input rate of 6.0 mmBtu/hr.

Emissions Unit Control Equipment

1. Control Equipment/Method Description (Limit to 200 characters per device or method):

NOx emission levels are controlled through the use of an electronic air/fuel ratio control to maintain lean combustion, electronic ignition system and a water-cooled aftercooler.

A lean (a higher air/fuel ratio) burn engine reduces thermal NOx formation in the combustion chambers because of air quenching. Caterpillar provides electronic engine controls that optimize engine operation by continually balancing power output, fuel economy and air/fuel ratio. These controls work to maintain lean combustion conditions, which result in the lowest emissions for NOx.

The Caterpillar Electronic Ignition System (EIS) system monitors engine operation and distributes power to the cylinder transformers, to provide the best engine performance at all engine speeds. It protects the engine from damage caused by detonation. EIS is capable of higher spark voltages, longer spark duration, and more precise timing control than a magneto system resulting in more complete and controlled combustion. The EIS package includes engine speed, timing, detonation, and intake manifold pressure sensors, and also an engine-mounted control module.

The water-cooled aftercooler reduces thermal NOx formation in the combustion chamber by cooling air prior to entering the combustion chamber.

PM emissions from natural gas fired engines are very low because natural gas is efficiently combusted and contains no ash. Combustion of natural gas under lean fuel conditions results in low PM and PM_{10} emissions.

2. Control Device or Method Code(s): 99

Emissions Unit Details

1. Package Unit: Manufacturer: Caterpillar	Model Number: G3512 LE-130	
2. Generator Nameplate Rating:	MW	
3. Incinerator Information:		
Dwell Temperature:		°F
Dwell Time:		seconds
Incinerator Afterburner Temperature:		°F

B. EMISSIONS UNIT CAPACITY INFORMATION
(Regulated Emissions Units Only)

Emissions Unit Operating Capacity and Schedule

1. Maximum Heat Input Rate:		105,120	mmBtu/yr
2. Maximum Incineration Rate:	lb/hr		tons/day
3. Maximum Process or Throughput Rate: Not Applicable			
4. Maximum Production Rate: Not Applicable			
5. Requested Maximum Operating Schedule:			
	24 hours/day	7	days/week
	52 weeks/year	8760	hours/year

6. Operating Capacity/Schedule Comment (limit to 200 characters):

Maximum Heat Input Rate is based on unrestricted operations for both units (17,520 hrs/yr)
7407 Btu/bhp-hr x 810 bhp x 1 mmBtu/100000 Btus x 2 (engines) x 8760 hrs/yr
= 105,120 mmBtu/yr.

C. EMISSIONS UNIT REGULATIONS
(Regulated Emissions Units Only)

List of Applicable Regulations

Chapter 62-4 Permits	
Rule 62-204.220 Ambient Air Quality Protection	
Rule 62-204.240 Ambient Air Quality Standards	
Rule 62-204.800 Federal Regulations Adopted by Reference	
Rule 62-210.200 Definitions	
Rule 62-210.300 Permits Required	
Rule 62-210.350 Public Notice and Comments	
Rule 62-210.370 Reports	
Rule 62-210.550 Stack Height Policy	
Rule 62-210.650 Circumvention	
Rule 62-210.700 Excess Emissions	
Rule 62-210.900 Forms and Instructions	
Rule 62-212.300 General Preconstruction Review Requirements	
Chapter 62-213 Operation Permits for Major Sources	
Rule 62-296.320 General Pollutant Emission Limiting Standards	

D. EMISSION POINT (STACK/VENT) INFORMATION
(Regulated Emissions Units Only)

Emission Point Description and Type

1. Identification of Point on Plot Plan or Flow Diagram? #3, #4 (G3512)	2. Emission Point Type Code: 3

3. Descriptions of Emission Points Comprising this Emissions Unit for VE Tracking (limit to 100 characters per point):
3 CC, Pump Engine No. 3 (4th from north end): vertical stack outside building with silencer.
4 CC, Pump Engine No. 4 (3rd from north end): vertical stack outside building with silencer.

4. ID Numbers or Descriptions of Emission Units with this Emission Point in Common:
003, 018, Unk – Pump Engine 3
004, 019, Unk – Pump Engine 4

5. Discharge Type Code: V	6. Stack Height: 32 feet	7. Exit Diameter: 1 feet
8. Exit Temperature: 801 °F	9. Actual Volumetric Flow Rate: 4260 acfm	10. Water Vapor: %

11. Maximum Dry Standard Flow Rate: dscfm	12. Nonstack Emission Point Height: feet

13. Emission Point UTM Coordinates:
Zone: 17 East (km): 566.6 North (km): 2,843.5

14. Emission Point Comment (limit to 200 characters):
Emission point is representative point of the two similar units

E. SEGMENT (PROCESS/FUEL) INFORMATION
(All Emissions Units)

Segment Description and Rate: Segment 1 of 1

1. Segment Description (Process/Fuel Type) (limit to 500 characters): Natural gas powered internal combustion engines (emissions related to thousand Cubic feet burned) Maximum hourly & annual fuel rates are based on brake specific fuel consumption of 7,407 BTU/bhp-hr. Annual fuel rate is for both units. Pump Engine Nos. 3 & 4 each consume 0.006348 MMCF/hr at rated capacity at 1050 MMBtu/MMScf.		
2. Source Classification Code (SCC): 1-02-006-02	3. SCC Units: Million Cubic Feet Burned (all gaseous fuels)	
4. Maximum Hourly Rate: 0.01143	5. Maximum Annual Rate: 100.11	6. Estimated Annual Activity Factor: 1.00
7. Maximum % Sulfur: 0.00	8. Maximum % Ash: 0.00	9. Million Btu per SCC Unit: 1.050
10. Segment Comment (limit to 200 characters): Maximum hourly rate of the two engines is 0.01143 MMscf/hr. The Maximum annual rate of two engines is based the hourly rate of 0.01143 MMscf/hr for 8760 hours or 100.11 MMscf/yr.		

Segment Description and Rate: Segment ___ of ___

1. Segment Description (Process/Fuel Type) (limit to 500 characters):		
2. Source Classification Code (SCC):	3. SCC Units:	
4. Maximum Hourly Rate:	5. Maximum Annual Rate:	6. Estimated Annual Activity Factor:
7. Maximum % Sulfur:	8. Maximum % Ash:	9. Million Btu per SCC Unit:
10. Segment Comment (limit to 200 characters):		

F. EMISSIONS UNIT POLLUTANTS
(All Emissions Units)

1. Pollutant Emitted	2. Primary Control Device Code	3. Secondary Control Device Code	4. Pollutant Regulatory Code
NOX	99		EL
PM			EL
CO			NS

G. EMISSIONS UNIT POLLUTANT DETAIL INFORMATION
(Regulated Emissions Units - Emissions-Limited and Preconstruction Review Pollutants Only)

Potential/Fugitive Emissions

1. Pollutant Emitted: NOX	2. Total Percent Efficiency of Control: 0.0
3. Potential Emissions: 7.14 lb/hour 31.3 tons/year	4. Synthetically Limited? [N]
5. Range of Estimated Fugitive Emissions: [ ] 1 [ ] 2 [ ] 3 _____ to _____ tons/year	
6. Emission Factor: 2.0 g/bhp-hr Reference: Manufacturer	7. Emissions Method Code: 5

8. Calculation of Emissions (limit to 600 characters):

Manufacturer Supplied NOx emissions: 2.0 g/bhp-hr NOx, each
Hourly Emissions: (2 engine) x (810 bhp) x (2.0 g/bhp-hr NOx) x (1 lb/454 g) = 7.14 lbs/hr.
Annual Emissions: (2 engines) x (810 bhp) x (2.0 g/bhp-hr NOx) x (1 lb/454 g) x (8,760 hr/yr) x (ton/2,000 lb) = 31.3 tpy

9. Pollutant Potential/Fugitive Emissions Comment (limit to 200 characters):
Hourly and Annual emissions are for both units 3 and 4.

Allowable Emissions Allowable Emissions 1 of 2

1. Basis for Allowable Emissions Code:	2. Future Effective Date of Allowable Emissions:
3. Requested Allowable Emissions and Units:	4. Equivalent Allowable Emissions: lb/hour tons/year

5. Method of Compliance (limit to 60 characters):

6. Allowable Emissions Comment (Desc. of Operating Method) (limit to 200 characters):
The emission unit is not subject to any unit specific emission limiting standard and considered "unregulated" for the purposes of Title V permitting.

G. EMISSIONS UNIT POLLUTANT DETAIL INFORMATION
(Regulated Emissions Units - Emissions-Limited and Preconstruction Review Pollutants Only)

Potential/Fugitive Emissions

1. Pollutant Emitted: CO	2. Total Percent Efficiency of Control: 0.0
3. Potential Emissions: 6.42 lb/hour 31.3 tons/year	4. Synthetically Limited? [N]
5. Range of Estimated Fugitive Emissions: [ ] 1 [ ] 2 [ ] 3 _____ to _____ tons/year	
6. Emission Factor: 1.8 g/bhp-hr Reference: Manufacturer	7. Emissions Method Code: 5

8. Calculation of Emissions (limit to 600 characters):

Manufacturer Supplied NOx emissions: 1.8 g/bhp-hr CO, each
Hourly Emissions: (2 engine) x (810 bhp) x (1.8 g/bhp-hr) x (1 lb/454 g) = 6.42 lbs/hr.
Annual Emissions: (2 engines) x (810 bhp) x (1.8 g/bhp-hr) x (1 lb/454 g) x (8,760 hr/yr) x (ton/2,000 lb) = 28.12 tpy

9. Pollutant Potential/Fugitive Emissions Comment (limit to 200 characters):
Hourly and Annual emissions are for both units 3 and 4.

Allowable Emissions Allowable Emissions 2 of 2

1. Basis for Allowable Emissions Code:	2. Future Effective Date of Allowable Emissions:
3. Requested Allowable Emissions and Units:	4. Equivalent Allowable Emissions: lb/hour tons/year

5. Method of Compliance (limit to 60 characters):

6. Allowable Emissions Comment (Desc. of Operating Method) (limit to 200 characters):
The emission unit is not subject to any unit specific emission limiting standard and considered "unregulated" for the purposes of Title V permitting.

H. VISIBLE EMISSIONS INFORMATION
(Only Regulated Emissions Units Subject to a VE Limitation)

Visible Emissions Limitation: Visible Emissions Limitation 1 of 1

1. Visible Emissions Subtype: VE20	2. Basis for Allowable Opacity: [X] Rule [ ] Other
3. Requested Allowable Opacity: Normal Conditions: 20 % Exceptional Conditions: 40 % Maximum Period of Excess Opacity Allowed: 2 min/hour	
4. Method of Compliance: Perform Initial VE Compliance monitoring using EPA Method 9.	
5. Visible Emissions Comment (limit to 200 characters):	

I. CONTINUOUS MONITOR INFORMATION
(Only Regulated Emissions Units Subject to Continuous Monitoring)

Continuous Monitoring System: Continuous Monitor _____ of _____

1. Parameter Code:	2. Pollutant(s):
3. CMS Requirement:	[ ] Rule [ ] Other
4. Monitor Information: Manufacturer: Model Number: Serial Number:	
5. Installation Date:	6. Performance Specification Test Date:
7. Continuous Monitor Comment (limit to 200 characters):	

J. EMISSIONS UNIT SUPPLEMENTAL INFORMATION
(Regulated Emissions Units Only)

Supplemental Requirements

1. Process Flow Diagram [ ] Attached, Document ID:_____ [X] Not Applicable [ ] Waiver Requested
2. Fuel Analysis or Specification [X] Attached, Document ID: A04 [ ] Not Applicable [ ] Waiver Requested
3. Detailed Description of Control Equipment [ ] Attached, Document ID:_____ [X] Not Applicable [ ] Waiver Requested
4. Description of Stack Sampling Facilities [X] Attached, Document ID: A05 [ ] Not Applicable [ ] Waiver Requested
5. Compliance Test Report [ ] Attached, Document ID:_____ [ ] Previously submitted, Date:_____ [X] Not Applicable
6. Procedures for Startup and Shutdown [X] Attached, Document ID: A06 [ ] Not Applicable [ ] Waiver Requested
7. Operation and Maintenance Plan [ ] Attached, Document ID:_____ [X] Not Applicable [ ] Waiver Requested
8. Supplemental Information for Construction Permit Application [X] Attached, Document ID: A07 [ ] Not Applicable
9. Other Information Required by Rule or Statute [ ] Attached, Document ID:_____ [X] Not Applicable
10. Supplemental Requirements Comment:

Additional Supplemental Requirements for Title V Air Operation Permit Applications

11. Alternative Methods of Operation
[ ] Attached, Document ID:_____ [X] Not Applicable

12. Alternative Modes of Operation (Emissions Trading)
[ ] Attached, Document ID:_____ [X] Not Applicable

13. Identification of Additional Applicable Requirements
[ ] Attached, Document ID:_____ [X] Not Applicable

14. Compliance Assurance Monitoring Plan
[ ] Attached, Document ID:_____ [X] Not Applicable

15. Acid Rain Part Application (Hard-copy Required)

[ ] Acid Rain Part - Phase II (Form No. 62-210.900(1)(a))
Attached, Document ID:_____

[ ] Repowering Extension Plan (Form No. 62-210.900(1)(a)1.)
Attached, Document ID:_____

[ ] New Unit Exemption (Form No. 62-210.900(1)(a)2.)
Attached, Document ID:_____

[ ] Retired Unit Exemption (Form No. 62-210.900(1)(a)3.)
Attached, Document ID:_____

[ ] Phase II NOx Compliance Plan (Form No. 62-210.900(1)(a)4.)
Attached, Document ID:_____

[ ] Phase NOx Averaging Plan (Form No. 62-210.900(1)(a)5.)
Attached, Document ID:_____

[X] Not Applicable

III. EMISSIONS UNIT INFORMATION

A separate Emissions Unit Information Section (including subsections A through J as required) must be completed for each emissions unit addressed in this Application for Air Permit. If submitting the application form in hard copy, indicate, in the space provided at the top of each page, the number of this Emissions Unit Information Section and the total number of Emissions Unit Information Sections submitted as part of this application.

A. GENERAL EMISSIONS UNIT INFORMATION
(All Emissions Units)

Emissions Unit Description and Status

1. Type of Emissions Unit Addressed in This Section: (Check one)

[X] This Emissions Unit Information Section addresses, as a single emissions unit, a single process or production unit, or activity, which produces one or more air pollutants and which has at least one definable emission point (stack or vent).

[ ] This Emissions Unit Information Section addresses, as a single emissions unit, a group of process or production units and activities which has at least one definable emission point (stack or vent) but may also produce fugitive emissions.

[ ] This Emissions Unit Information Section addresses, as a single emissions unit, one or more process or production units and activities which produce fugitive emissions only.

2. Regulated or Unregulated Emissions Unit? (Check one)

[X] The emissions unit addressed in this Emissions Unit Information Section is a regulated emissions unit.

[ ] The emissions unit addressed in this Emissions Unit Information Section is an unregulated emissions unit.

3. Description of Emissions Unit Addressed in This Section (limit to 60 characters):
Pump Engine No. 5 (Natural Gas)

4. Emissions Unit Identification Number:
ID:
[ ] No ID
[X] ID Unknown

5. Emissions Unit Status Code:	6. Initial Startup Date:	7. Emissions Unit Major Group SIC Code:	8. Acid Rain Unit?
C		49	[ ]

9. Emissions Unit Comment: (Limit to 500 Characters)
Pump engine no. 5 (E.U. ID Nos. 005) began service in August 1951 will be replaced by this new unit. Permit 0250314-003-AC authorized the replacement of this unit with a 2090 bhp natural gas fired Waukesau Model 8L-AT27GL engine with a maximum heat input rate of 13.70 mmBtu/hr as (E.U. ID No. 020). This is to replace unit with 2225 bhp natural gas fired Caterpillar Model G3808LE engine with a heat input rate of 15.15 mmBtu/hr.

Emissions Unit Control Equipment

1. Control Equipment/Method Description (Limit to 200 characters per device or method):

NOx emission levels are controlled through the use of an electronic air/fuel ratio control to maintain lean combustion, pre-combustion chamber, electronic ignition system and a water-cooled aftercooler.

A lean (a higher air/fuel ratio) burn engine reduces thermal NOx formation in the combustion chambers because of air quenching. Caterpillar provides electronic engine controls that optimize engine operation by continually balancing power output, fuel economy and air/fuel ratio. These controls work to maintain lean combustion conditions, which result in the lowest emissions for NOx.

A pre-combustion chamber allows for an appropriate air/fuel mixture for proper spark ignition and combustion in pre-combustion chamber, and a leaner air/fuel mixture in the main combustion chamber, resulting in lower NOx emissions.

The Caterpillar Electronic Ignition System (EIS) system monitors engine operation and distributes power to the cylinder transformers, to provide the best engine performance at all engine speeds. It protects the engine from damage caused by detonation. EIS is capable of higher spark voltages, longer spark duration, and more precise timing control than a magneto system resulting in more complete and controlled combustion. The EIS package includes engine speed, timing, detonation, and intake manifold pressure sensors, and also an engine-mounted control module.

The water-cooled aftercooler reduces thermal NOx formation in the combustion chamber by cooling air prior to entering the combustion chamber.

PM emissions from natural gas fired engines are very low because natural gas is efficiently combusted and contains no ash. Combustion of natural gas under lean fuel conditions results in low PM and PM_{10} emissions.

2. Control Device or Method Code(s): 99

Emissions Unit Details

1. Package Unit:
   Manufacturer: Caterpillar Model Number: G3808 LE-130

2. Generator Nameplate Rating: MW

3. Incinerator Information:
   Dwell Temperature: °F
   Dwell Time: seconds
   Incinerator Afterburner Temperature: °F

B. EMISSIONS UNIT CAPACITY INFORMATION
(Regulated Emissions Units Only)

Emissions Unit Operating Capacity and Schedule

1. Maximum Heat Input Rate:			132.734	mmBtu/yr
2. Maximum Incineration Rate:	lb/hr			tons/day
3. Maximum Process or Throughput Rate:				
4. Maximum Production Rate:				
5. Requested Maximum Operating Schedule:				
	24	hours/day	7	days/week
	52	weeks/year	8760	hours/year

6. Operating Capacity/Schedule Comment (limit to 200 characters):

Maximum Heat Input Rate is based on unrestricted operations.
6810 Btu/bhp-hr x 2225 bhp x 1 mmBtu/100000 Btus x 8760 hrs/yr = 132,734 mmBtu/yr.
Maximum Heat Input Rate: 16.67 mmBtu/hr is 110% of rated capacity of 15.15 mmBtu/hr

C. EMISSIONS UNIT REGULATIONS
(Regulated Emissions Units Only)

List of Applicable Regulations

Chapter 62-4 Permits	
Rule 62-204.220 Ambient Air Quality Protection	
Rule 62-204.240 Ambient Air Quality Standards	
Rule 62-204.800 Federal Regulations Adopted by Reference	
Rule 62-210.200 Definitions	
Rule 62-210.300 Permits Required	
Rule 62-210.350 Public Notice and Comments	
Rule 62-210.370 Reports	
Rule 62-210.550 Stack Height Policy	
Rule 62-210.650 Circumvention	
Rule 62-210.700 Excess Emissions	
Rule 62-210.900 Forms and Instructions	
Rule 62-212.300 General Preconstruction Review Requirements	
Chapter 62-213 Operation Permits for Major Sources	
Rule 62-296.320 General Pollutant Emission Limiting Standards	

D. EMISSION POINT (STACK/VENT) INFORMATION
(Regulated Emissions Units Only)

Emission Point Description and Type

1. Identification of Point on Plot Plan or Flow Diagram? # 5 SDR (G3608)	2. Emission Point Type Code: 3	
3. Descriptions of Emission Points Comprising this Emissions Unit for VE Tracking (limit to 100 characters per point): # 5 SDR, Pump Engine No. 5 (2nd from north end): vertical stack outside building with silencer.		
4. ID Numbers or Descriptions of Emission Units with this Emission Point in Common:		
5. Discharge Type Code: V	6. Stack Height: 32 feet	7. Exit Diameter: 1.5 feet
8. Exit Temperature: 842 °F	9. Actual Volumetric Flow Rate: 14816 acfm	10. Water Vapor: %
11. Maximum Dry Standard Flow Rate: dscfm	12. Nonstack Emission Point Height: feet	
13. Emission Point UTM Coordinates: Zone: 17 East (km): 566.6 North (km): 2,843.5		
14. Emission Point Comment (limit to 200 characters):		

E. SEGMENT (PROCESS/FUEL) INFORMATION
(All Emissions Units)

Segment Description and Rate: Segment 1 of 1

1. Segment Description (Process/Fuel Type) (limit to 500 characters): Natural gas powered internal combustion engines (emissions related to thousand Cubic feet burned) Maximum hourly & annual fuel rates are based on brake specific fuel consumption of 6810 BTU/bhp-hr. Pump Engine No. 5 consumes 0.01443 MMscf/hr at rated capacity or a maximum of 0.0159 MMcf/hr at 110 percent capacity at 1050 MMBtu/MMScf.		
2. Source Classification Code (SCC): 1-02-006-02	3. SCC Units: Million Cubic Feet Burned (all gaseous fuels)	
4. Maximum Hourly Rate: 0.0159	5. Maximum Annual Rate: 126.41	6. Estimated Annual Activity Factor: 1.00
7. Maximum % Sulfur: 0.00	8. Maximum % Ash: 0.00	9. Million Btu per SCC Unit: 1,050
10. Segment Comment (limit to 200 characters): Maximum hourly rate of the engine is 0.0159 MMscf/hr. The Maximum annual rate is based the nominal capacity of 0.01443 MMscf/hr and 8760 hrs/yr or 126.41 MMscf/yr		

Segment Description and Rate: Segment ___ of ___

1. Segment Description (Process/Fuel Type) (limit to 500 characters):		
2. Source Classification Code (SCC):	3. SCC Units:	
4. Maximum Hourly Rate:	5. Maximum Annual Rate:	6. Estimated Annual Activity Factor:
7. Maximum % Sulfur:	8. Maximum % Ash:	9. Million Btu per SCC Unit:
10. Segment Comment (limit to 200 characters):		

F. EMISSIONS UNIT POLLUTANTS
(All Emissions Units)

1. Pollutant Emitted	2. Primary Control Device Code	3. Secondary Control Device Code	4. Pollutant Regulatory Code
NOX	99		EL
PM			EL
CO			NS

Emissions Unit Information Section 2 of 3

Pollutant Detail Information Page 1 of 2

G. EMISSIONS UNIT POLLUTANT DETAIL INFORMATION
(Regulated Emissions Units - Emissions-Limited and Preconstruction Review Pollutants Only)

Potential/Fugitive Emissions

1. Pollutant Emitted: NOX	2. Total Percent Efficiency of Control: 0.0
3. Potential Emissions: 3.43 lb/hour 15.03 tons/year	4. Synthetically Limited? [N]
5. Range of Estimated Fugitive Emissions: [ ] 1 [ ] 2 [ ] 3 _____ to _____ tons/year	
6. Emission Factor: 0.7 g/bhp-hr Reference: Manufacturer	7. Emissions Method Code: 5

8. Calculation of Emissions (limit to 600 characters):

Manufacturer Supplied NOx emissions: 0.7 g/bhp-hr NOx
Hourly Emissions: (2225 bhp) x (0.7 g/bhp-hr NOx) x (1 lb/454 g) = 3.43 lbs/hr.
Annual Emissions: (2225 bhp) x (0.7 g/bhp-hr NOx) x (1 lb/454 g) x (8,760 hr/yr) x (ton/2,000 lb) = 15.03 tpy

9. Pollutant Potential/Fugitive Emissions Comment (limit to 200 characters):

Allowable Emissions Allowable Emissions 1 of 2

1. Basis for Allowable Emissions Code:	2. Future Effective Date of Allowable Emissions:
3. Requested Allowable Emissions and Units:	4. Equivalent Allowable Emissions: lb/hour tons/year

5. Method of Compliance (limit to 60 characters):

6. Allowable Emissions Comment (Desc. of Operating Method) (limit to 200 characters):
The emission unit is not subject to any unit specific emission limiting standard and considered "unregulated" for the purposes of Title V permitting.

Emissions Unit Information Section 2 of 3

Pollutant Detail Information Page 1 of 2

G. EMISSIONS UNIT POLLUTANT DETAIL INFORMATION
(Regulated Emissions Units - Emissions-Limited and Preconstruction Review Pollutants Only)

Potential/Fugitive Emissions

1. Pollutant Emitted: CO	2. Total Percent Efficiency of Control: 0.0
3. Potential Emissions: 12.25 lb/hour 53.67 tons/year	4. Synthetically Limited? [N]
5. Range of Estimated Fugitive Emissions: [ ] 1 [ ] 2 [ ] 3 _____ to _____ tons/year	
6. Emission Factor: 2.5 g/bhp-hr Reference: Manufacturer	7. Emissions Method Code: 5
8. Calculation of Emissions (limit to 600 characters): Manufacturer Supplied CO emissions: 2.5 g/bhp-hr CO Hourly Emissions: (2225 bhp) x (2.5 g/bhp-hr) x (1 lb/454 g) = 12.25 lbs/hr. Annual Emissions: (2225 bhp) x (2.5 g/bhp-hr) x (1 lb/454 g) x (8,760 hr/yr) x (ton/2,000 lb) = 53.67 tpy	
9. Pollutant Potential/Fugitive Emissions Comment (limit to 200 characters):	

Allowable Emissions Allowable Emissions 2 of 2

1. Basis for Allowable Emissions Code:	2. Future Effective Date of Allowable Emissions:
3. Requested Allowable Emissions and Units:	4. Equivalent Allowable Emissions: lb/hour tons/year
5. Method of Compliance (limit to 60 characters): Initial air compliance testing	
6. Allowable Emissions Comment (Desc. of Operating Method) (limit to 200 characters): The emission unit is not subject to any unit specific emission limiting standard and considered "unregulated" for the purposes of Title V permitting.	

H. VISIBLE EMISSIONS INFORMATION
(Only Regulated Emissions Units Subject to a VE Limitation)

Visible Emissions Limitation: Visible Emissions Limitation 1 of 1

1. Visible Emissions Subtype: VE20	2. Basis for Allowable Opacity: [X] Rule [ ] Other
3. Requested Allowable Opacity: Normal Conditions: 20 % Exceptional Conditions: 40 % Maximum Period of Excess Opacity Allowed: min/hour	
4. Method of Compliance: Perform Initial VE Compliance monitoring using EPA Method 9.	
5. Visible Emissions Comment (limit to 200 characters):	

I. CONTINUOUS MONITOR INFORMATION
(Only Regulated Emissions Units Subject to Continuous Monitoring)

Continuous Monitoring System: Continuous Monitor _____ of _____

1. Parameter Code:	2. Pollutant(s):
3. CMS Requirement:	[ ] Rule [ ] Other
4. Monitor Information: Manufacturer: Model Number: Serial Number:	
5. Installation Date:	6. Performance Specification Test Date:
7. Continuous Monitor Comment (limit to 200 characters):	

J. EMISSIONS UNIT SUPPLEMENTAL INFORMATION
(Regulated Emissions Units Only)

Supplemental Requirements

1. Process Flow Diagram [ ] Attached, Document ID: _____ [X] Not Applicable [ ] Waiver Requested
2. Fuel Analysis or Specification [X] Attached, Document ID: A04 [ ] Not Applicable [ ] Waiver Requested
3. Detailed Description of Control Equipment [ ] Attached, Document ID:_____ [X] Not Applicable [ ] Waiver Requested
4. Description of Stack Sampling Facilities [ ] Attached, Document ID:_____ [X] Not Applicable [ ] Waiver Requested
5. Compliance Test Report [ ] Attached, Document ID:_____ [ ] Previously submitted, Date:_____ [X] Not Applicable
6. Procedures for Startup and Shutdown [X] Attached, Document ID: A06 [ ] Not Applicable [ ] Waiver Requested
7. Operation and Maintenance Plan [ ] Attached, Document ID:_____ [X] Not Applicable [ ] Waiver Requested
8. Supplemental Information for Construction Permit Application [X] Attached, Document ID:_____ [ ] Not Applicable
9. Other Information Required by Rule or Statute [ ] Attached, Document ID: A08 [X] Not Applicable
10. Supplemental Requirements Comment:

Additional Supplemental Requirements for Title V Air Operation Permit Applications

11. Alternative Methods of Operation
[ ] Attached, Document ID:_____ [X] Not Applicable

12. Alternative Modes of Operation (Emissions Trading)
[ ] Attached, Document ID:_____ [X] Not Applicable

13. Identification of Additional Applicable Requirements
[ ] Attached, Document ID:_____ [X] Not Applicable

14. Compliance Assurance Monitoring Plan
[ ] Attached, Document ID:_____ [X] Not Applicable

15. Acid Rain Part Application (Hard-copy Required)

[ ] Acid Rain Part - Phase II (Form No. 62-210.900(1)(a))
Attached, Document ID:_____

[ ] Repowering Extension Plan (Form No. 62-210.900(1)(a)1.)
Attached, Document ID:_____

[ ] New Unit Exemption (Form No. 62-210.900(1)(a)2.)
Attached, Document ID:_____

[ ] Retired Unit Exemption (Form No. 62-210.900(1)(a)3.)
Attached, Document ID:_____

[ ] Phase II NOx Compliance Plan (Form No. 62-210.900(1)(a)4.)
Attached, Document ID:_____

[ ] Phase NOx Averaging Plan (Form No. 62-210.900(1)(a)5.)
Attached, Document ID:_____

[X] Not Applicable

III. EMISSIONS UNIT INFORMATION

A separate Emissions Unit Information Section (including subsections A through J as required) must be completed for each emissions unit addressed in this Application for Air Permit. If submitting the application form in hard copy, indicate, in the space provided at the top of each page, the number of this Emissions Unit Information Section and the total number of Emissions Unit Information Sections submitted as part of this application.

A. GENERAL EMISSIONS UNIT INFORMATION
(All Emissions Units)

Emissions Unit Description and Status

1. Type of Emissions Unit Addressed in This Section: (Check one)

[X] This Emissions Unit Information Section addresses, as a single emissions unit, a single process or production unit, or activity, which produces one or more air pollutants and which has at least one definable emission point (stack or vent).

[ ] This Emissions Unit Information Section addresses, as a single emissions unit, a group of process or production units and activities which has at least one definable emission point (stack or vent) but may also produce fugitive emissions.

[ ] This Emissions Unit Information Section addresses, as a single emissions unit, one or more process or production units and activities which produce fugitive emissions only.

2. Regulated or Unregulated Emissions Unit? (Check one)

[X] The emissions unit addressed in this Emissions Unit Information Section is a regulated emissions unit.

[ ] The emissions unit addressed in this Emissions Unit Information Section is an unregulated emissions unit.

3. Description of Emissions Unit Addressed in This Section (limit to 60 characters):
Pump/Generator engine no. 1 - 900 KW emergency generator

4. Emissions Unit Identification Number:
ID:
[ ] No ID
[X] ID Unknown

5. Emissions Unit Status Code:	6. Initial Startup Date:	7. Emissions Unit Major Group SIC Code:	8. Acid Rain Unit?
C		49	[ ]

9. Emissions Unit Comment: (Limit to 500 Characters)
Pump engine no. 1 (Emission Unit ID No. 001) driving a pump and a 750 KW generator will be permanently removed from service and replaced with a 1337 bhp diesel fuel fired Caterpillar Model 3508 engine coupled to a 900 KW (820 KW prime rating) generator with a maximum heat input rate of 9.18 mmBtu/hr.

Emissions Unit Control Equipment

1. Control Equipment/Method Description (Limit to 200 characters per device or method):

NOx emission levels are controlled through the use of a water-cooled aftercooler. The water-cooled aftercooler reduces thermal NOx formation in the combustion chamber by cooling air prior to entering the combustion chamber.

2. Control Device or Method Code(s): 99

Emissions Unit Details

1. Package Unit:
   Manufacturer: Caterpillar Model Number: 3508

2. Generator Nameplate Rating: 0.9 MW

3. Incinerator Information:
   Dwell Temperature: °F
   Dwell Time: seconds
   Incinerator Afterburner Temperature: °F

B. EMISSIONS UNIT CAPACITY INFORMATION
(Regulated Emissions Units Only)

Emissions Unit Operating Capacity and Schedule

1. Maximum Heat Input Rate:			9.18	mmBtu/hr
2. Maximum Incineration Rate:	lb/hr			tons/day
3. Maximum Process or Throughput Rate:				
4. Maximum Production Rate:				
5. Requested Maximum Operating Schedule:				
	24	hours/day	7	days/week
	52	weeks/year	500	hours/year

6. Operating Capacity/Schedule Comment (limit to 200 characters):

Unit will serve as an emergency standby generator for the East pump room.

Maximum heat input is based on a fuel consumption of 66.5 gal/hr and 138 mmBtu/1000gals.

C. EMISSIONS UNIT REGULATIONS
(Regulated Emissions Units Only)

List of Applicable Regulations

Chapter 62-4 Permits	
Rule 62-204.220 Ambient Air Quality Protection	
Rule 62-204.240 Ambient Air Quality Standards	
Rule 62-204.800 Federal Regulations Adopted by Reference	
Rule 62-210.200 Definitions	
Rule 62-210.300 Permits Required	
Rule 62-210.350 Public Notice and Comments	
Rule 62-210.370 Reports	
Rule 62-210.550 Stack Height Policy	
Rule 62-210.650 Circumvention	
Rule 62-210.700 Excess Emissions	
Rule 62-210.900 Forms and Instructions	
Rule 62-212.300 General Preconstruction Review Requirements	
Chapter 62-213 Operation Permits for Major Sources	
Rule 62-296.320 General Pollutant Emission Limiting Standards	

D. EMISSION POINT (STACK/VENT) INFORMATION
(Regulated Emissions Units Only)

Emission Point Description and Type

1. Identification of Point on Plot Plan or Flow Diagram? CAT 3508	2. Emission Point Type Code: 3	
3. Descriptions of Emission Points Comprising this Emissions Unit for VE Tracking (limit to 100 characters per point): A single exhaust stack integral with and located directly above the unit.		
4. ID Numbers or Descriptions of Emission Units with this Emission Point in Common:		
5. Discharge Type Code: V	6. Stack Height: 18 feet	7. Exit Diameter: 0.67 feet
8. Exit Temperature: 884 °F	9. Actual Volumetric Flow Rate: 7331 acfm	10. Water Vapor: %
11. Maximum Dry Standard Flow Rate: 2473 dscfm	12. Nonstack Emission Point Height: feet	
13. Emission Point UTM Coordinates: Zone: 17 East (km): 566.6 North (km): 2,843.5		
14. Emission Point Comment (limit to 200 characters):		

E. SEGMENT (PROCESS/FUEL) INFORMATION
(All Emissions Units)

Segment Description and Rate: Segment 1 of 1

1. Segment Description (Process/Fuel Type) (limit to 500 characters): Unit is fueled by diesel, no. 2 fuel oil. The maximum hourly & annual fuel rates are based on a consumption of 66.5 gal/hr.		
2. Source Classification Code (SCC): 2-02-004-01	3. SCC Units: 1000 Gallons	
4. Maximum Hourly Rate: 0.0665	5. Maximum Annual Rate: 33.25	6. Estimated Annual Activity Factor: 0.06
7. Maximum % Sulfur: 0.05	8. Maximum % Ash: 0.00	9. Million Btu per SCC Unit: 138
10. Segment Comment (limit to 200 characters): Maximum rate of the engine is 66.5 gal/hr, or 0.0665 (1000gal)/hr. The maximum annual rate is 0.0665 (1000gal)/hr x 500 hrs/yr = 33.25 (1000 gal)/yr		

Segment Description and Rate: Segment ___ of ___

1. Segment Description (Process/Fuel Type) (limit to 500 characters):		
2. Source Classification Code (SCC):	3. SCC Units:	
4. Maximum Hourly Rate:	5. Maximum Annual Rate:	6. Estimated Annual Activity Factor:
7. Maximum % Sulfur:	8. Maximum % Ash:	9. Million Btu per SCC Unit:
10. Segment Comment (limit to 200 characters):		

F. EMISSIONS UNIT POLLUTANTS
(All Emissions Units)

1. Pollutant Emitted	2. Primary Control Device Code	3. Secondary Control Device Code	4. Pollutant Regulatory Code
NOX			EL
CO			EL
PM			NS

G. EMISSIONS UNIT POLLUTANT DETAIL INFORMATION
(Regulated Emissions Units -
Emissions-Limited and Preconstruction Review Pollutants Only)

Potential/Fugitive Emissions

1. Pollutant Emitted: NOX	2. Total Percent Efficiency of Control: 0.0
3. Potential Emissions: 37.47 lb/hour 9.37 tons/year	4. Synthetically Limited? [Y]
5. Range of Estimated Fugitive Emissions: [ ] 1 [ ] 2 [ ] 3 _____ to _____ tons/year	
6. Emission Factor: 37.46 lb/hr Reference: Manufacturer	7. Emissions Method Code: 5
8. Calculation of Emissions (limit to 600 characters): Manufacturer Supplied NOx emissions: 37.46 lb/hr NOx Hourly Emissions: 37.46 lb/hr Annual Emissions: (37.46 lb/hr NOx) x (500 hr/yr) x (ton/2,000 lb) = 9.37 tpy	
9. Pollutant Potential/Fugitive Emissions Comment (limit to 200 characters):	

Allowable Emissions Allowable Emissions 1 of 2

1. Basis for Allowable Emissions Code: RULE	2. Future Effective Date of Allowable Emissions:
3. Requested Allowable Emissions and Units: 4.75 lbs/mmBTU	4. Equivalent Allowable Emissions: 43.6 lb/hour 10.9 tons/year
5. Method of Compliance (limit to 60 characters): Initial air compliance testing using EPA Method 7 or 7E	
6. Allowable Emissions Comment (Desc. of Operating Method) (limit to 200 characters): Equivalent Allowable Emissions is based on NOx RACT Rule (4.75 lbs/mmBTU NOx) x 0.0665 (1000gals)/hr x 138 mmBTU/(1000gals) = 43.6 lbs NOx (4.75 lbs/mmBTU NOx) x 33.15 (1000gals)/hr x 138 mmBTU/(1000gals) x 1 ton/2000 lbs = 10.9 tons NOx	

Emissions Unit Information Section 3 of 3

Pollutant Detail Information Page 1 of 2

G. EMISSIONS UNIT POLLUTANT DETAIL INFORMATION
(Regulated Emissions Units -
Emissions-Limited and Preconstruction Review Pollutants Only)

Potential/Fugitive Emissions

1. Pollutant Emitted: CO	2. Total Percent Efficiency of Control:
3. Potential Emissions: 2.10 lb/hour 42.924 tons/year	4. Synthetically Limited? [Y]
5. Range of Estimated Fugitive Emissions: [ ] 1 [ ] 2 [ ] 3 _____ to _____ tons/year	
6. Emission Factor: 2.10 lb/hr Reference: Manufacturer	7. Emissions Method Code: 5
8. Calculation of Emissions (limit to 600 characters): Manufacturer Supplied CO emissions: 2.10 lb/hr CO Hourly Emissions: 2.10 lb/hr Annual Emissions: (2.10lb/hr CO) x (500 hr/yr) x (ton/2,000 lb) = 0.525 tpy	
9. Pollutant Potential/Fugitive Emissions Comment (limit to 200 characters):	

Allowable Emissions Allowable Emissions 2 of 2

1. Basis for Allowable Emissions Code: OTHER	2. Future Effective Date of Allowable Emissions:
3. Requested Allowable Emissions and Units:	4. Equivalent Allowable Emissions: lb/hour tons/year
5. Method of Compliance (limit to 60 characters):	
6. Allowable Emissions Comment (Desc. of Operating Method) (limit to 200 characters):	

H. VISIBLE EMISSIONS INFORMATION
(Only Regulated Emissions Units Subject to a VE Limitation)

Visible Emissions Limitation: Visible Emissions Limitation 1 of 1

1. Visible Emissions Subtype: VE20	2. Basis for Allowable Opacity: [X] Rule [ ] Other
3. Requested Allowable Opacity: Normal Conditions: 20 % Exceptional Conditions: 40 % Maximum Period of Excess Opacity Allowed: 6 min/hour	
4. Method of Compliance: Perform Initial VE Compliance monitoring using EPA Method 9.	
5. Visible Emissions Comment (limit to 200 characters):	

I. CONTINUOUS MONITOR INFORMATION
(Only Regulated Emissions Units Subject to Continuous Monitoring)

Continuous Monitoring System: Continuous Monitor _____ of _____

1. Parameter Code:	2. Pollutant(s):
3. CMS Requirement:	[ ] Rule [ ] Other
4. Monitor Information: Manufacturer: Model Number: Serial Number:	
5. Installation Date:	6. Performance Specification Test Date:
7. Continuous Monitor Comment (limit to 200 characters):	

J. EMISSIONS UNIT SUPPLEMENTAL INFORMATION
(Regulated Emissions Units Only)

Supplemental Requirements

1. Process Flow Diagram [ ] Attached, Document ID: _____ [X] Not Applicable [ ] Waiver Requested
2. Fuel Analysis or Specification [X] Attached, Document ID: A04 [ ] Not Applicable [ ] Waiver Requested
3. Detailed Description of Control Equipment [ ] Attached, Document ID: _____ [X] Not Applicable [ ] Waiver Requested
4. Description of Stack Sampling Facilities [X] Attached, Document ID: A05 [ ] Not Applicable [X] Waiver Requested
5. Compliance Test Report [ ] Attached, Document ID: _____ [ ] Previously submitted, Date: _____ [ ] Not Applicable
6. Procedures for Startup and Shutdown [X] Attached, Document ID: A06 [ ] Not Applicable [ ] Waiver Requested
7. Operation and Maintenance Plan [ ] Attached, Document ID: _____ [X] Not Applicable [ ] Waiver Requested
8. Supplemental Information for Construction Permit Application [X] Attached, Document ID: A09 [ ] Not Applicable
9. Other Information Required by Rule or Statute [ ] Attached, Document ID: _____ [X] Not Applicable
10. Supplemental Requirements Comment:

Additional Supplemental Requirements for Title V Air Operation Permit Applications

11. Alternative Methods of Operation
[ ] Attached, Document ID:_____ [X] Not Applicable

12. Alternative Modes of Operation (Emissions Trading)
[ ] Attached, Document ID:_____ [X] Not Applicable

13. Identification of Additional Applicable Requirements
[ ] Attached, Document ID:_____ [X] Not Applicable

14. Compliance Assurance Monitoring Plan
[ ] Attached, Document ID:_____ [X] Not Applicable

15. Acid Rain Part Application (Hard-copy Required)

[ ] Acid Rain Part - Phase II (Form No. 62-210.900(1)(a))
Attached, Document ID:_____

[ ] Repowering Extension Plan (Form No. 62-210.900(1)(a)1.)
Attached, Document ID:_____

[ ] New Unit Exemption (Form No. 62-210.900(1)(a)2.)
Attached, Document ID:_____

[ ] Retired Unit Exemption (Form No. 62-210.900(1)(a)3.)
Attached, Document ID:_____

[ ] Phase II NOx Compliance Plan (Form No. 62-210.900(1)(a)4.)
Attached, Document ID:_____

[ ] Phase NOx Averaging Plan (Form No. 62-210.900(1)(a)5.)
Attached, Document ID:_____

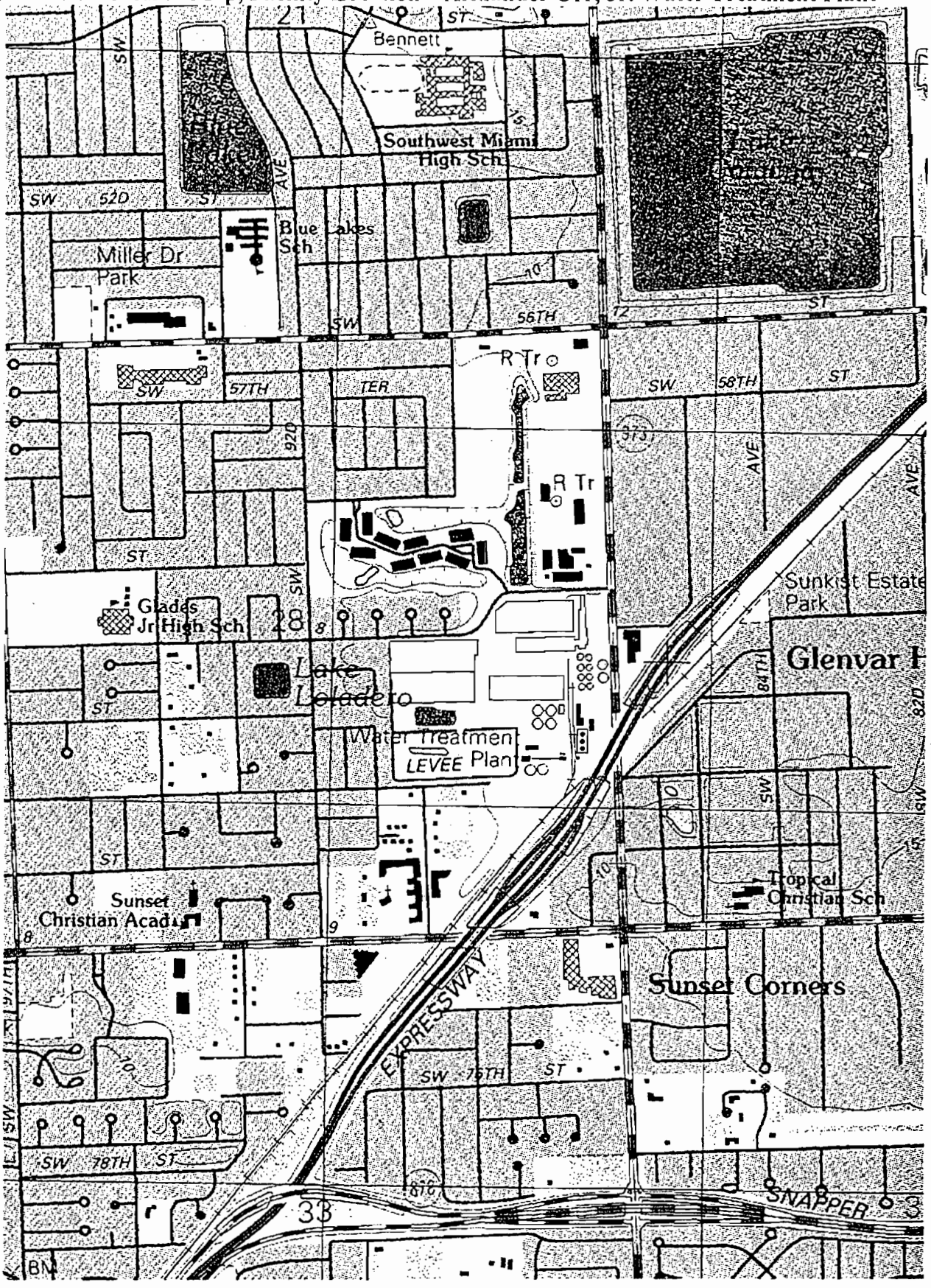
[X] Not Applicable

Attachment 1

Area Map (USGS)
Aerial Photograph (USGS)

South Miami, Florida

Item 1. Area Map, Facility Location – Alexander Orr, Jr. Water Treatment Plant

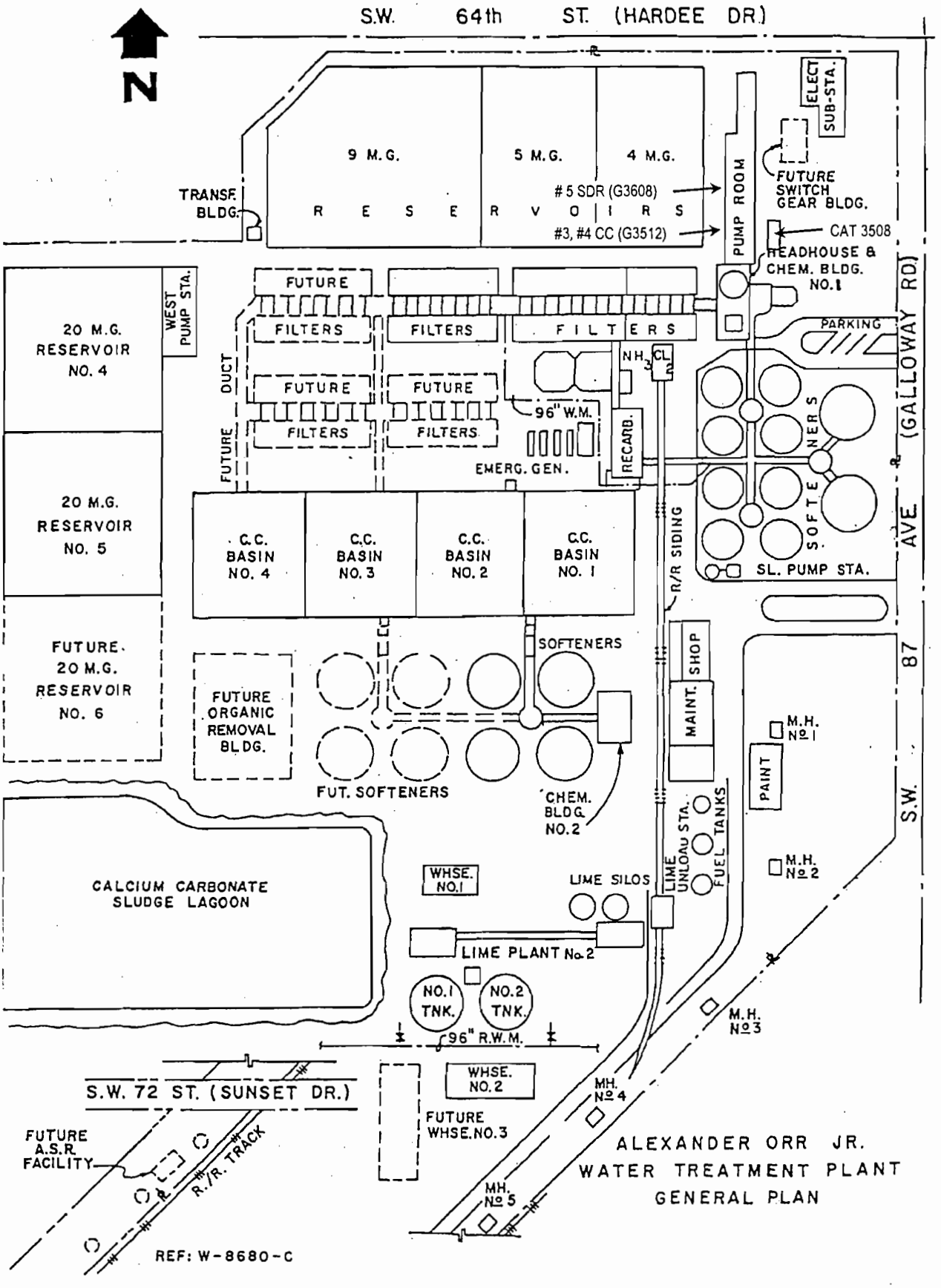


Attachment 2

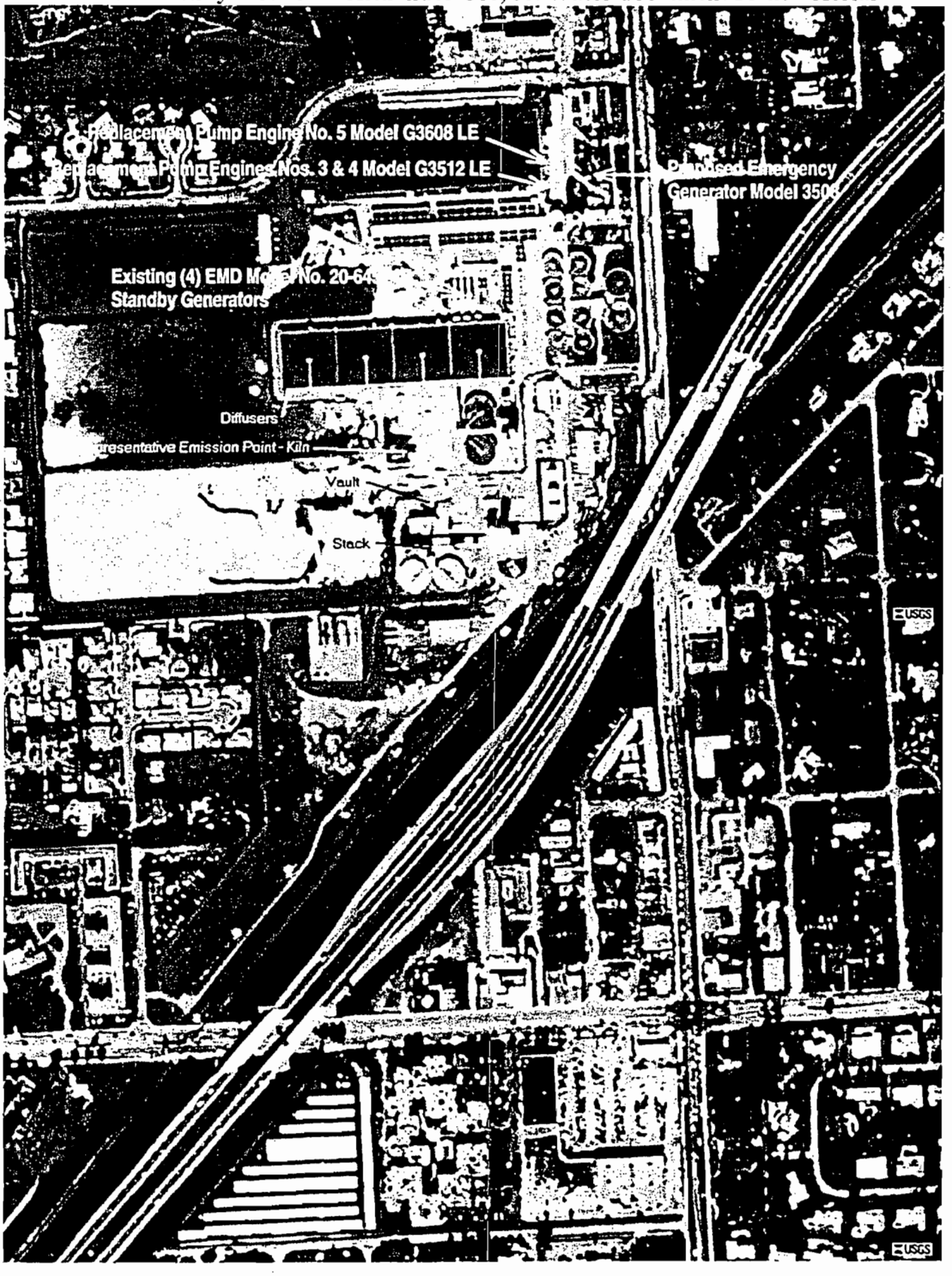
Site Maps

Alexander Orr, Jr.
Water Treatment Plant

Item 2. Facility Plot Plan– Alexander Orr, Jr. Water Treatment Plant



Item 2. Facility Plot Plan– Alexander Orr, Jr. Water Treatment Plant – Aerial



Attachment 3

Emission Calculations - Nox
Replacement Sources

Alexander Orr, Jr.
Water Treatment Plant

Miami-Dade Water and Sewer Department
Alexander Orr, Jr. Water Treatment Plant --- East Pump Room - Pump Replacement Project
Replacement of Pump Diesel Engines Nos. 1, 3 & 4 and Pump Dual Fueled Engine No. 5
Calculations of Past Actual Emissions from Existing Engine Driven Pumps and Proposed Replacements

Existing Annual Pump Engine Emissions

Average Annual Operations -- April 1998 - March 2000

	Pump/Gen Engine 1 - 825 bhp	Pump Engine 3 - 825 bhp	Pump Engine 4 - 825 bhp	Sum Pump Engines 3 & 4 - 825 bhp	Pump Engine 5 - 1590 bhp	Total Pump Engines 1, 3, 4 & 5
Annual Average Operating Hours, 24-Month Period, April 1998 - March 2000	142.5	1,306.3	1,543.0	2,849.3	2,513.8	5,363.0
Brake Horsepower	825	825	825		1,590	
Fuel Consumption [1] gals/hr	30.1	31.0	29.5		59.2	
Average Annual Fuel consumption in gallons 10^3	4.285	40.495	45.524	86.019	148.773	234.8
MMbtus based on 138 / SCC Unit (10^3 gallons)	591	5,588	6,282	11,870.6	20,531	32,401

	Emission Factor	Units	Source or SCC[2]	Annual Emissions in Tons: Pump/Gen Engine 1 - 825 bhp	Pump Engine 3 - 825 bhp	Pump Engine 4 - 825 bhp	Sum Pump Engines 3 & 4 - 825 bhp	Pump Engine 5 - 1590 bhp	Total Pump Engines 1, 3, 4 & 5
Average Nitrogen Oxides (NOx) Emissions		Lbs/mmBTU	Tests	2.19	2.10	2.76		2.45	
Nitrogen Oxides (NOx)	-	-		0.65	5.87	8.67	14.54	25.15	**40.33**
Carbon Monoxide (CO)	1.11E+02	Lbs/1000gals	20200401	0.24	2.25	2.53	4.77	8.26	**13.27**
PM, Total	9.55E+00	Lbs/1000gals	20200401	0.02	0.19	0.22	0.41	0.71	**1.14**
PM_{10}, Total	7.85E+00	Lbs/1000gals	20200401	0.02	0.16	0.18	0.34	0.58	**0.94**
Sulfur Oxides (SOx)	6.90E+00	Lbs/1000gals	20200401	0.00	0.01	0.01	0.01	0.03	**0.04**
VOC, Total	1.37E+01	Lbs/1000gals	20200401	0.03	0.28	0.31	0.59	1.02	**1.64**

Notes:
1. Estimated rates based on usage prior to service tank change, less than full load rates.
2. EPA Source Classification Codes
3. Emissions Factors based on Emissions Testing, Manufacturer Supplied Data or EPA Source Classification Codes
4. Emissions (tons/yr) = (emission factor [lbs/unit]) x (units) / 2000 lbs/ton
5. Net Annual Increase / (Decrease) in Tons of Emissions (tons/yr) = Proposed Annual Emissions (tons/yr) - Past Annual Emissions (tons/yr)

Miami-Dade Water and Sewer Department
Alexander Orr, Jr. Water Treatment Plant --- East Pump Room - Pump Replacement Project
Replacement of Pump Diesel Engines Nos. 1, 3 & 4 and Pump Dual Fueled Engine No. 5
Calculations of Past Actual Emissions from Existing Engine Driven Pumps and Proposed Replacements

Proposed Annual Engine Emissions

	Proposed Annual Operations				
	900 KW GenSet	Pump Engine 3	Pump Engine 4	Sum Pump Engines 3 & 4	Pump Engine 5
Hours of Operation	500	8,760	8,760	17,520	8,760
Fuel Consumption in 1000gals/hr or MMCF/hr	0.0665	5.714	5.714		14.431
Annual Fuel consumption in 1000gals or MMCF	33.25	50.06	50.06	100.11	126.41
Annual Heat Input (mmBtus) based on 1050/ MMCF or 138 /1000 gals	4,589	52,560	52,560	105,120	132,734
Engine Brake Specific Horsepower (bhp)	1,332	810	810		2,225

Annual Emissions in Tons

	Emission Factor	Units	Source, SCC[2]	900 KW GenSet 3508	Pump Engine 3 G3512	Pump Engine 4 G3512	Σ Pump Engines 3 & 4 G3512	Pump Engine 5 G3608	Total 900 KW GenSet & Pump Engines 3,4 &	Net Annual Increase / (Decrease) in Tons
Nitrogen Oxides (NOx)	-	gr/bhp-hr	Manufacturer		2.00	2.00		0.70		
Nitrogen Oxides (NOx)	-	Lbs/Hr	Manufacturer	37.46						
Nitrogen Oxides (NOx)	-	**Tons**		9.40	15.60	15.60	31.20	15.00	55.60	**15.27**
Carbon Monoxide (CO)	-	gr/bhp-hr	Manufacturer		1.60	1.60		2.50		
Carbon Monoxide (CO)	-	Lbs/Hr	Manufacturer	3.10						
Carbon Monoxide (CO)	-	**Tons**		0.80	12.50	12.50	25.00	53.70	79.50	**66.23**
Particulate Matter (PM)	-	gr/bhp-hr	Manufacturer							
Particulate Matter (PM)	-	Lbs/Hr	Manufacturer	0.310						
PM, Filterable	1.00E+01	Lbs/MMCF	20300201		0.25	0.25		0.63		
PM	-	**Tons**		0.08	0.25	0.25	0.50	0.63	1.21	**0.07**
Particulate Matter (PM_{10})	-	gr/bhp-hr	Manufacturer		0.30	0.30				
Particulate Matter (PM_{10})	-	Lbs/Hr	Manufacturer	0.310						
PM_{10}, Filterable	1.00E+01	Lbs/MMCF	20300201					0.63		
PM_{10}	-	**Tons**		0.08	2.30	2.30	4.60	0.63	5.31	**4.37**
Sulfur Oxides (SOx)	6.00E-01	Lbs/MMCF	20300201		0.02	0.02		0.04		
Sulfur Oxides (SOx)	6.90E+00	Lbs/1000gals	20200401	0.11						
Sulfur Oxides (SOx)	-	**Tons**		0.11	0.02	0.02	0.04	0.04	0.19	**0.15**
Volatile Organic Compounds (VOC)	1.16E+02	Lbs/MMCF	20300201		2.90	2.90		7.30		
Volatile Organic Compounds (VOC)	1.37E+01	Lbs/1000gals	20200401	0.20						
Volatile Organic Compounds (VOC)	-	**Tons**		0.20	2.90	2.90	5.80	7.30	13.30	**11.66**

Notes:
1. Estimated rates based on usage prior to service tank change, less than full load rates.
2. EPA Source Classification Codes
3. Emissions Factors based on Emissions Testing, Manufacturer Supplied Data or EPA Source Classification Codes
4. Emissions (tons/yr) = (emission factor [lbs/unit]) x (units) / 2000 lbs/ton
5. Net ual Increase / (Decrease) in Tons of Emissions (tons/yr) = Proposed Annual Emissic ns/yr) - Past Annual Emissions (tons/yr)

Miami-Dade Water and Sewer Department
Alexander Orr, Jr. Water Treatment Plant --- East Pump Room - Pump Replacement Project
Replacement of Pump Diesel Engines Nos. 1, 3 & 4 and Pump Dual Fueled Engine No. 5
Calculations of Potential Emissions from Unrestricted Operations of Existing Engine Driven Pumps and Proposed Replacements

Annual Pump Engine Emissions from Permitted Unrestricted Operations.

				Annual Operations					
				Pump/Gen Engine 1 - 825 bhp	Pump Engine 3 - 825 bhp	Pump Engine 4 - 825 bhp	Sum Pump Engines 3 & 4 - 825 bhp	Pump Engine 5 - 1590 bhp	Total Pump Engines 1, 3, 4 & 5
			Hours of Operation	8,760.0	8,760.0	8,760.0	17,520.0	8,760.0	26,280.0
			Brake Horsepower	825	825	825		1,590	
			Fuel Consumption [1] gals/hr	30.1	31.0	29.5		59.2	
			Average Annual Fuel consumption in gallons 10^3	263.415	271.568	258.448	530.016	518.449	1,048.5
			MMbtus based on 138 / SCC Unit (10^3 gallons)	36,351	37,476	35,666	73,142.2	71,546	144,688
				Annual Emissions in Tons					
	Emission Factor	Units	Source or SCC[2]	Pump/Gen Engine 1 - 825 bhp	Pump Engine 3 - 825 bhp	Pump Engine 4 - 825 bhp	Sum Pump Engines 3 & 4 - 825 bhp	Pump Engine 5 - 1590 bhp	Total Pump Engines 1, 3, 4 & 5
Average Nitrogen Oxides (NOx) Emissions		Lbs/mmBTU	Tests	2.19	2.10	2.76		2.45	
Nitrogen Oxides (NOx)	-	-		39.80	39.35	49.22	88.57	87.64	**216.02**
Carbon Monoxide (CO)	1.11E+02	Lbs/1000gals	20200401	14.62	15.07	14.34	29.42	28.77	**72.81**
PM, Total	9.55E+00	Lbs/1000gals	20200401	1.26	1.30	1.23	2.53	2.48	**6.26**
PM_{10}, Total	7.85E+00	Lbs/1000gals	20200401	1.03	1.07	1.01	2.08	2.03	**5.15**
Sulfur Oxides (SOx)	6.90E+00	Lbs/1000gals	20200401	0.05	0.05	0.04	0.09	0.09	**0.23**
VOC, Total	1.37E+01	Lbs/1000gals	20200401	1.80	1.86	1.77	3.63	3.55	**8.99**

Notes:
1. Estimated rates based on usage prior to service tank change, less than full load rates.
2. EPA Source Classification Codes
3. Emissions Factors based on Emissions Testing, Manufacturer Supplied Data or EPA Source Classification Codes
4. Emissions (tons/yr) = (emission factor [lbs/unit]) x (units) / 2000 lbs/ton
5. Net Annual Increase / (Decrease) in Tons of Emissions (tons/yr) = Proposed Annual Emissions (tons/yr) - Past Annual Emissions (tons/yr)

Miami-Dade Water and Sewer Department
Alexander Orr, Jr. Water Treatment Plant --- East Pump Room - Pump Replacement Project
Replacement of Pump Diesel Engines Nos. 1, 3 & 4 and Pump Dual Fueled Engine No. 5
Calculations of Potential Emissions from Unrestricted Operations of Existing Engine Driven Pumps and Proposed Replacements

Potential Unrestricted Annual Proposed Engine Emissions

Unrestricted Annual Operations

	900 KW GenSet	Pump Engine 3	Pump Engine 4	Sum Pump Engines 3 & 4	Pump Engine 5
Hours of Operation	8,760	8,760	8,760	17,520	8,760
Fuel Consumption in 1000gals/hr or MCF/hr	0.0665	5.714	5.714		14.431
Annual Fuel consumption in 1000gals or MMCF	582.54	50.06	50.06	100.11	126.41
Annual Heat Input (mmBtus) based on 1050/ MMCF or 138 /1000 gals	80,391	52,560	52,560	105,120	132,734
Engine Brake Specific Horsepower (bhp)	1,332	810	810		2,225

Annual Emissions in Tons

	Emission Factor	Units	Source, SCC[2]	900 KW GenSet 3508	Pump Engine 3 G3512	Pump Engine 4 G3512	Σ Pump Engines 3 & 4 G3512	Pump Engine 5 G3608	Total 900 KW GenSet & Pump Engines 3,4 &	Net Annual Increase / (Decrease) in Tons
Nitrogen Oxides (NOx)	-	gr/bhp-hr	Manufacturer		2.00	2.00		0.70		
Nitrogen Oxides (NOx)	-	Lbs/Hr	Manufacturer	37.46						
Nitrogen Oxides (NOx)	-	Tons		164.10	15.60	15.60	31.20	15.00	210.30	(5.72)
Carbon Monoxide (CO)	-	gr/bhp-hr	Manufacturer		1.60	1.60		2.50		
Carbon Monoxide (CO)	-	Lbs/Hr	Manufacturer	3.10						
Carbon Monoxide (CO)	-	Tons		13.60	12.50	12.50	25.00	53.70	92.30	19.49
Particulate Matter (PM)	-	gr/bhp-hr	Manufacturer							
Particulate Matter (PM)	-	Lbs/Hr	Manufacturer	0.310						
PM, Filterable	1.00E+01	Lbs/MMCF	20300201		0.25	0.25		0.63		
PM	-	Tons		1.36	0.25	0.25	0.50	0.63	2.49	(3.77)
Particulate Matter (PM_{10})	-	gr/bhp-hr	Manufacturer		0.30	0.30				
Particulate Matter (PM_{10})	-	Lbs/Hr	Manufacturer	0.310						
PM_{10}, Filterable	1.00E+01	Lbs/MMCF	20300201					0.63		
PM_{10}	-	Tons		1.36	2.30	2.30	4.60	0.63	6.59	1.44
Sulfur Oxides (SOx)	6.00E-01	Lbs/MMCF	20300201		0.02	0.02		0.04		
Sulfur Oxides (SOx)	6.90E+00	Lbs/1000gals	20200401	2.01						
Sulfur Oxides (SOx)	-	Tons		2.01	0.02	0.02	0.04	0.04	2.09	1.86
Volatile Organic Compounds (VOC)	1.16E+02	Lbs/MMCF	20300201		2.90	2.90		7.30		
Volatile Organic Compounds (VOC)	1.37E+01	Lbs/1000gals	20200401	4.00						
Volatile Organic Compounds (VOC)	-	Tons		4.00	2.90	2.90	5.80	7.30	17.10	8.11

Notes:
1. Estimated rates based on usage prior to service tank change, less than full load rates.
2. EPA Source Classification Codes
3. Emissions Factors based on Emissions Testing, Manufacturer Supplied Data or EPA Source Classification Codes
4. Emissions (tons/yr) = (emission factor [lbs/unit]) x (units) / 2000 lbs/ton
5. Net Annual Increase / (Decrease) in Tons of Emissions (tons/yr) = Proposed Annual Emissions (tons/yr) - Past Annual Emissions (tons/yr)

CATERPILLAR®

Caterpillar Inc.
9701 State Road 26 East
Lafayette, IN 47905-4259

14 June 2000

Gas Engine Emissions Letter

PROJECT:	MDWASD Alexander WTP	BSFC:	7407 BTU/bhp-hr
model:	G3512	fuel pressure:	45 psi
compression ratio:	8:1	fuel LHV:	963 btu/ft3
A/C inlet temp:	130 ° F	fuel MN:	72.7
J/W outlet temp:	210 ° F	site altitude:	sea lvl ft
rating:	810 bhp @	max. ambient	110 ° F
	1200 rpm	timing	31 ° BTDC

		100%
Engine Power	bhp	810
Exhaust O2	%	8.30
NOx (as NO2)	g/bhp-hr	2.00
	tons/year	15.64
CO	g/bhp-hr	1.60
	tons/year	12.51
total HC	g/bhp-hr	3.10
	tons/year	24.25
non-methane HC	g/bhp-hr	0.50
	tons/year	3.91
NMNEHC	g/bhp-hr	0.50
	tons/year	3.91
Formaldehydes	g/bhp-hr	0.27
	tons/year	2.11
PM10	lbs/bhp-hr	0.30

Emission levels are based on engine operation under steady state conditions, adjusted to the specified NOx level at 100% load. The CO, total HC, and non-methane HC values listed are 20% higher than nominal levels to allow for instrumentation, measurement, and engine-to-engine variations; these values indicate "not to exceed" levels. Tons per year values are based on 8,760 hours of operation per year. This information is valid for engine orders placed within six months of the above date. Please contact the factory if an extension of this period is required.

Sincerely,

Jeffery A. Elijah

Applications Engineer
Technical/Commercial Services
Petroleum Business Unit

Approved: Performance Engineer

Jayson Hagler

Technical Manager

Robert Mazzon

G3512 LE Gas Industrial Engine Performance

CATERPILLAR®

Engine Speed (rpm)	1200	Fuel	NAT GAS
Compression Ratio	8:1	LHV of Fuel (Btu/SCF)	920
Aftercooler Inlet Temperature (°F)	130	Fuel System	HPG IMPCO
Jacket Water Outlet Temperature (°F)	210		
Ignition System	EIS	Minimum Fuel Pressure (psig)	35
Exhaust Manifold	WATER COOLED	Methane Number at Conditions Shown	80
Combustion System Type	LOW EMISSION	Rated Altitude (ft)	5000
		at 77°F Design Temperature	

G3512

Engine Rating Data	% Load	100%	75%	50%
Engine Power (w/o fan)	bhp	810	607	405
Engine Data				
Specific Fuel Consumption (BSFC) (1)	Btu/bhp-hr	7407	7600	7937
Air Flow (Wet, @ 77°F, 28.6 in Hg)	SCFM	1668	1209	827
Air Mass Flow (Wet)	lb/hr	7395	5362	3665
Compressor Out Pressure	in. HG (abs)	69.6	62.2	46.5
Compressor Out Temperature	°F	289	261	186
Inlet Manifold Pressure	in. HG (abs)	60.8	45.9	32.3
Inlet Manifold Temperature (10)	°F	138	134	134
Timing (11)	°BTDC	33	33	33
Exhaust Stack Temperature	°F	801	786	777
Exhaust Gas Flow (Wet, @ stack temperature, 29.7 in Hg)	CFM	4260	3060	2080
Exhaust Gas Mass Flow (Wet)	lb/hr	7683	5584	3823
Engine Emissions Data				
Nitrous Oxides (NOx as NO2) (9)	g/bhp-hr	2.0	3.3	3.3
(Corr. 15% 02)	ppm	124	245	231
Carbon Monoxide (CO) (9)	g/bhp-hr	1.6	1.7	1.9
(Corr. 15% 02)	ppm	195	212	215
Total Hydrocarbons (THC) (9)	g/bhp-hr	3.1	2.8	3.2
(Corr. 15% 02)	ppm	678	604	644
Non-Methane Hydrocarbons (NMHC) (9)	g/bhp-hr	0.47	0.42	0.48
(Corr. 15% 02)	ppm	48	40	41
Exhaust Oxygen (9)	%	8.2	7.4	7.0
Lambda		1.58	1.49	1.43
Engine Heat Balance Data				
Input Energy LHV (1)	Btu/min	99992	76948	53571
Work Output	Btu/min	34365	25774	17183
Heat Rejection to Jacket (2) (6)	Btu/min	31421	26759	20465
Heat Rejection to Atmosphere (Radiated) (4)	Btu/min	3643	3036	2429
Heat Rejection to Lube Oil (5)	Btu/min	0	0	0
Total Heat Rejection to Exhaust (to 77°F) (2)	Btu/min	25965	18439	12609
Heat Rejection to Exhaust (LHV to 350°F) (2)	Btu/min	15457	10904	7330
Heat Rejection to Aftercooler (3) (7) (8)	Btu/min	4598	2880	885

CATERPILLAR

Caterpillar Inc.
Lafayette Engine Center
Lafayette, Indiana 47903

June 15, 2000

Gas Engine Emissions Letter

Project:	MDWASD Alexander WTP			
Model:	G3608 LE	Rating (note below):	2225	bhp @ 1000 rpm
Compression Ratio:	9.1	ESFC (Btu/bhp-hr):	6810	+/- 3.0%
A/C Inlet Temp. (°F):	130	J/W Outlet Temp. (°F):	190	
Fuel LHV (Btu/ft3):	963	Altitude (ft):	sea level	
Fuel MN:	72.7	Ambient (°F):	110	

	NOx (as NO2)	CO	THC	NMHC	NMNEHC
g/bhp-hr	0.70	2.50	8.00	1.05	0.51
tons/year	15.0	53.7	128.9	22.6	11.0

Exhaust Mass Flow (lbs/hr, wet):	25,543
Exhaust Volume Flow (cfm, wet): @ 842°F stack temp, 14.5 psia	14,816

Emission levels are based on engine operation at steady state conditions adjusted to the specified NOx level. The CO, THC, NMHC, and NMNEHC values listed are higher than nominal levels to allow for instrumentation, measurement, and engine-to-engine variations. They indicate "not to exceed" values. Tons per year values are based on 8,760 hours of operation per year.

This information is valid for engine orders placed within six (6) months of the above date. Please contact the factory after six months if an extension is required.

Sincerely,

Jeffery A. Elijah
G3600 Applications
Lafayette Engine Center

mG3600emissn2000d0-092.xls

G3608 SITA 9:1 Industrial Performance

			100%	75%	50%	25%
piration		TA	TA	TA	TA
Speed	rpm	1000	1000	1000	1000
JW Outlet Temperature (°F)		190	190	190	190
A/C Inlet Temperature (°F)		130	130	130	130
Engine Power	bhp[1]	2225	1669	1113	556
NOx (as NO_2)	g/bhp-hr[2]	0.70	0.70	0.70	1.20
CO	g/bhp-hr[2]	1.90	1.90	1.90	2.20
HC (Total)	g/bhp-hr[2]	5.95	6.30	6.50	6.00
HC (Non-Methane)	g/bhp-hr[2]	0.89	0.95	0.98	0.90
Exhaust Oxygen	% (dry)	12.3	11.7	10.7	10.2
BSFC	Btu/hp-hr	6810	7035	7550	9620
Compressor Out Pressure	in Hg abs	70.4	54.2	38.6	32.0
Compressor Out Temp (°F)		290	238	154	132
Intake Manifold Pressure	in Hg abs	69.7	53.8	38.3	23.9
Intake Manifold Temp (°F)		148	143	140	136
Air-Fuel Ratio	vol/vol	20.09	19.93	18.57	17.40
Timing	°BTDC	20.2	20.2	19	16.2
Fuel Energy	Btu/min[3]	252538	195661	139990	89185
ust (LHV)	Btu/min[4]	97042	76771	56282	34002
aust (to 350°F)	Btu/min[4]	58201	46698	34427	22433
Aftercooler	Btu/min[5]	16141	8285	1113	63
Radiation - Engine only	Btu/min[6]	11177	10468	9659	8740
Oil Cooler	Btu/min[7]	10325	10025	9750	9450
Jacket Water	Btu/min[4]	23467	19324	15993	13334
Air Flow	lb/hr	25760	19794	13195	7876
Air Flow (scfm @ 77°F, 13.9 psia)		6136	4715	3143	1876
Exhaust Flow	lb/hr	26537	20396	13626	8150
Exh Flow (cfm @ stack T, 14.5 psia)		14867	11610	8048	4978
Exhaust Stack Temp (°F)		847	868	918	965
Fuel Flow (scfh 4 @ 60°F, 14.7 psia)		16743	12972	9281	5913

1) Continuous output and reference conditions according to ISO 3046/1 (77°F, 14.5 psia), Natural gas LHV = 905 Btu/sft^3.
(Engine power conversion: 1 bhp = 42.42 Btu/min)
2) Emissions data shown are not to exceed values.
3) Tolerance +/-2.5%
4) Tolerance +/- 10%, jacket water heat rejection based on treated water as coolant
5) Tolerance +/- 5%, heat rejection based on treated water as coolant
arance +/- 25%
lerance +/- 20%, heat rejection based on treated water as coolant

PANTROPIC POWER PRODUCTS, INC.

8205 N.W. 58th Street , Miami, FL 33166

FAX COVER

DATE: 10 – 20 - 00	FROM: Robert Butt . Project Manager
COMPANY: MIAMI DADE WASA	TEL. # (305) 592-4944 , ext 3108
ATTN : MR. RICHARD O'ROURKE	FAX # (305) – 574 - 7875
FAX # : (305 – 669 - 5749 TEL) Fax # 305-669-5717	REFERENCE : REQUEST FOR INFORMATION
PAGES : 3 (Including this page)	ALEXANDER ORR JR. WTP PROJECT GENERATOR EQUIPMENT

(PLEASE ADVISE IMMEDIATELY IF ALL PAGES ARE NOT RECEIVED)

Mr. O'Rourke :

Please find attached Caterpillar factory issued technical information pertaining to the generator set engine exhaust emissions and fuel consumption data in response to your inquiry.
This information is specific to the generator set model that is to be furnished by Pantropic Power Products , Inc. for the above referenced Project.

Response: Date:

3508 DI TA JW DRY MANF TURBO QTY WDWRD GOV
TM4516-09 PGS STANDBY 60 HERTZ
GEN 900.0 W/F EKW 930.0 W/O F EKW W/F BHP 1337 W/O F BHP @ 1800 RPM
CERTIFICATION YEAR CERT AGENCY
INFO CODE 01 - GENERAL PERFORMANCE DATA *

GEN W/F EKW	PER CENT LOAD	ENG PWR BHP	ENG BMEP PSI	S FUEL CONSUM LB/BHP-HR	FUEL RATE GPH	INTAKE MANF T DEG F	INTAKE MANF P IN-HG	INTAKE AIR FL CFM	EXH MANF T DEG F	EXH STK T DEG F	EXH GAS FL CFM
900.0	100	1332	278	.350	66.5	214	78.3	2821	1262	884	7327
810.0	90	1202	251	.346	59.4	208	71.8	2691	1177	831	6695
720.0	80	1073	224	.344	52.8	203	64.5	2532	1103	787	6073
675.0	75	1009	211	.346	49.8	202	60.6	2436	1079	776	5787
630.0	70	945	197	.347	46.8	200	56.4	2334	1052	764	5484
540.0	60	817	171	.350	40.9	198	47.8	2112	1000	742	4866
450.0	50	691	144	.357	35.2	196	39.4	1886	952	723	4269
360.0	40	568	119	.368	29.9	195	31.2	1667	906	705	3708

3508 DI TA JW DRY MANF TURBO QTY WDWRD GOV
TM4516-09 PGS STANDBY 60 HERTZ
GEN 900.0 W/F EKW 930.0 W/O F EKW W/F BHP 1337 W/O F BHP @ 1800 RPM
CERTIFICATION YEAR CERT AGENCY
INFO CODE 01 - GENERAL PERFORMANCE DATA *

GEN W/F EKW	PER CENT LOAD	ENG PWR BHP	ENG BMEP PSI	S FUEL CONSUM LB/BHP-HR	FUEL RATE GPH	INTAKE MANF T DEG F	INTAKE MANF P IN-HG	INTAKE AIR FL CFM	EXH MANF T DEG F	EXH STK T DEG F	EXH GAS FL CFM
270.0	30	443	93	.386	24.4	193	23.0	1441	858	686	3157
225.0	25	379	79	.400	21.6	192	19.2	1335	827	670	2888
180.0	20	315	66	.420	18.9	191	16.2	1250	780	640	2638
90.0	10	184	38	.504	13.3	189	10.8	1098	670	564	2157

3508 DI TA JW DRY MANF TURBO QTY WDWRD GOV
TM4516-09 PGS STANDBY 60 HERTZ
GEN 900.0 W/F EKW 930.0 W/O F EKW W/F BHP 1337 W/O F BHP @ 1800 RPM

INFO CODE 02 - HEAT REJECTION DATA *

GEN W/F EKW	PER CENT LOAD	REJ TO JW BTU/MN	REJ TO ATMOS BTU/MN	REJ TO EXH BTU/MN	EXH RCOV TO 350F BTU/MN	FROM OIL CLR BTU/MN	FROM AFT CLR BTU/MN	WORK ENERGY BTU/MN	LHV ENERGY BTU/MN	HHV ENERGY BTU/MN
900.0	100	34804	8246	53116	28435	7621	11033	56472	142743	152070
810.0	90	31051	7166	46633	24227	6768	9327	50955	127559	135862
720.0	80	27639	6483	41231	20530	6028	7621	45496	113228	120621
675.0	75	26103	6199	38842	19222	5687	6824	42766	106915	113853
630.0	70	24511	5971	36454	17857	5346	5971	40036	100432	106972
540.0	60	21440	5573	31847	15241	4663	4322	34691	87750	93494
450.0	50	18483	5175	27525	12909	4038	2957	29288	75637	80585
360.0	40	15639	4777	23430	10805	3412	1763	24113	64035	68244

3508 DI TA JW DRY MANF TURBO QTY WDWRD GOV
TM4516-09 PGS STANDBY 60 HERTZ
GEN 900.0 W/F EKW 930.0 W/O F EKW W/F BHP 1337 W/O F BHP @ 1800 RPM

INFO CODE 02 - HEAT REJECTION DATA *

GEN W/F EKW	PER CENT LOAD	REJ TO JW BTU/MN	REJ TO ATMOS BTU/MN	REJ TO EXH BTU/MN	EXH RCOV TO 350F BTU/MN	FROM OIL CLR BTU/MN	FROM AFT CLR BTU/MN	WORK ENERGY BTU/MN	LHV ENERGY BTU/MN	HHV ENERGY BTU/MN

EMISSIONS

3508 DI TA JW DRY MANF TURBO QTY WDWRD GOV
TM4516-09 PGS STANDBY 60 HERTZ EXH STK DIA 8.0 IN
GEN 900.0 W/F EKW 930.0 W/O F EKW W/F BHP 1337 W/O F BHP @ 1800 RPM

INFO CODE 05 - EMISSIONS DATA * * REFERENCE NOTES - NOT TO EXCEED * * * * * * *
EMISSIONS DATA MEASUREMENT IS CONSISTENT WITH THOSE DESCRIBED IN EPA CFR 40 PART 86 SUBPART D AND ISO 8178-1 FOR MEASURING HC, CO, CO2 AND NOX. THESE PROCEDURES ARE VERY SIMILAR TO THE METHODS DESCRIBED IN EPA CFR 40 PART 60 APPENDIX A METHOD 25A FOR HYDROCARBONS, METHOD 10 FOR CO, METHOD 7E FOR NOX.

DATA SHOWN IS BASED ON STEADY STATE ENGINE OPERATING CONDITIONS OF 77 DEG F, 28.42 IN HG AND NUMBER 2 DIESEL FUEL WITH 35 DEG API AND LHV OF 18,390 BTU/LB.

TO PROPERLY APPLY THIS DATA YOU MUST REFER TO PERFORMANCE PARAMETER DM1176 FOR ADDITIONAL INFORMATION, (APPLICATION GKN402, PROGRAM 03).

3508 DI TA JW DRY MANF TURBO QTY WDWRD GOV
TM4516-09 PGS STANDBY 60 HERTZ EXH STK DIA 8.0 IN
GEN 900.0 W/F EKW 930.0 W/O F EKW W/F BHP 1337 W/O F BHP @ 1800 RPM

INFO CODE 05 - EMISSIONS DATA * * * * * RATED SPEED * * * * STANDARD TIMING
"NOT TO EXCEED DATA"

GEN PWR EKW	% LOAD	ENG PWR BHP	NOX (AS NO2) * * * * * * * *	CO	TOTAL HC LB/HR * * * * * * * *	PART MATTER %	O2 (DRY) IN EXH (VOL) %	SMOKE OPAC %	BOSCH SMOKE NO.
900.0	100	1332.2	37.46	2.10	.68	.310	9.90	1.0	1.28
675.0	75	1008.8	33.07	1.22	.77	.250	11.40	0.9	1.28
450.0	50	690.9	25.67	.83	.46	.190	12.40	1.0	1.28
225.0	25	378.9	16.92	.82	.34	.150	13.50	1.0	1.28

3508 DI TA JW DRY MANF TURBO QTY WDWRD GOV
TM4516-09 PGS STANDBY 60 HERTZ EXH STK DIA 8.0 IN
GEN 900.0 W/F EKW 930.0 W/O F EKW W/F BHP 1337 W/O F BHP @ 1800 RPM

INFO CODE 05 - EMISSIONS DATA * * * * * RATED CONDITIONS * * STANDARD TIMING
"NOMINAL DATA"
AT RATED:

WET EXHAUST MASS	12838 LB/HR
WET EXHAUST FLOW (884 DEG F STACK TEMP)	7331 CFM
WET EXHAUST FLOW RATE (32 DEG F AND 29.98 IN HG)	2681 STD CFM
DRY EXHAUST FLOW RATE (32 DEG F AND 29.98 IN HG)	2473 STD CFM
FUEL FLOW RATE	66.0 GAL/HR

Attachment 4

Fuel Specifications
Natural Gas
Diesel Fuel

Alexander Orr, Jr.
Water Treatment Plant

City Gas Company of Florida

Miami Division
955 East 25th Street
Hialeah, FL 33013-3498
Tel: (305) 691-8710
Fax: (305) 691-7112
www.nui.com

NUI Corporation (NYSE: NUI)

July 22, 1998

Mr. Wilfredo M. Fernandez
Miami Dade Water & Sewer Department
P.O. Box 330316
Miami, Florida 33233-0316

Re: Heating Value of natural gas

Dear Wilfredo:

Attached please find a fuel analysis provided to City Gas by Florida Gas Trnasmission Company. In it you will note that the heating value of the natural gas delivered to City Gas is 1058 Btu/cf at standard pressure and temperature

Please, call me if you have any questions or need additional information.

Sincerely,

Adrian S. Morera
Key Account Manager
Enclosure

cc: J. Pappas
M. Blanco-Pape
V. Fernandez-Cuervo
T. Chu
J. Murias
F. Sagastume
Project File (~~CS~~ WWFER 46495)
~~R. O'Rourke~~

BEST AVAILABLE COPY

Spot Analysis of Natural Gas for Delivery in Florida

(West Palm Beach Chromatograph)

DATE: November 17, 1997

TIME: 06:12

Component Name	Mole %
Hexane	0.094
Propane	0.865
Isobutane	0.215
n-Butane	0.175
Isopentane	0.064
n-Pentane	0.037
Nitrogen	0.387
Methane	93.317
CO2	1.029
Ethane	3.814
Totals	100.000

Dry Btu/cf @ 14.730 psia and 60°F= 1058.4

Real Relative Density= 0.6037

Total Sulfur	NA PPM
H^2S	NA PPM
H^2O	4.41 lb/MMcf

MIAMI-DADE WATER AND SEWER DEPT.
RECEIVED
JUL 23 1998
ENGINEERING DIVISION
(PROJECT MANAGER)

MIAMI-DADE WATER AND SEWER DEPT.
RECEIVED
JUL 23 1998
ENGINEERING DIVISION
(PROJECT MANAGER)

Non-Negotiable Bill of Lading

MATERIAL SAFETY DATA SHEET AVAILABLE FROM THE TERMINAL FOR THESE PRODUCTS ON REQUEST

CUSTOMER NOTICE – THE PRODUCT TRANSFER DOCUMENTS FOR THIS TRANSACTION INCLUDE OTHER DOCUMENTS WHICH MAY CONTAIN ADDITIONAL AND/OR CORRECTING REFORMULATED GASOLINE INFORMATION. IF IN CONFLICT, THE INFORMATION IN THE OTHER DOCUMENTS WILL CONTROL.

BEST AVAILABLE COPY

Form 50605-A Rev. 11/97

SEE REVERSE SIDE FOR HAZARD WARNING INFORMATION & NOTES

DRIVER SIGNATURE:

ALL ITEMS SUBJECT TO CONDITIONS ON REVERSE SIDE HEREOF.

TRUCK SEAL NUMBERS:

SHIPMENT RECEIVED BY:

For Product Emergency
Spill, Leak, Fire, Exposure or Accident, CALL
CHEMTREC - Day or Night 800-424-9300

COPY 6

MARATHON ASHLAND PETROLEUM LLC, 539 S. MAIN STREET FINDLAY OHIO 45840 EPA 4268
*** CONVENTIONAL GASOLINES - THESE PRODUCTS DO NOT MEET THE REQUIREMENTS FOR REFORMULATED GASOLINES (RFG) AND MAY NOT USED IN ANY RFG COVERED AREA. *** SHIPPED FROM: 1601 S.E. 20TH STREET, FT. LAUDERDALE, FL 33316

DATE 08/14/01
NUMBER 549224-226
TIME IN 0940
TIME OUT 0955

SOLD TO (CONSIGNEE)	SHIPPED FROM	LOC CODE
BP OIL COMPANY EX MANSFIELD OIL CO _ (UNB) FL, DEST.	FT LAUDERDALE TERMIN 1601 SE 20TH ST FT LAUDERDALE FLA	0000499440

DATE SHIPPED	SHIPPED VIA
08/14/01	BILL FREIGHT UNKNOWN 3547 PENN TANK LINES

DESTINATION	CUSTOMER NUMBER	ITEM NUMBE
UNKNOWN FL	2304134600000	

DRIVER	TRAILER	COMPANY	CUSTOMER P.O. AND RELEASE NUMBER	TRANSMITTED CUSTOM AND RELEASE NUMBE
11604	4550	0505		
LOUIS EIBER				

CARGO TANK COMPARTMENT PRODUCT DESCRIPTIONS	GROSS GAL	NET GAL	TEMP./API GR.	COMMENTS
NO2 LOW SULFUR, .05% MAX SULFUR, 40 CETANE MIN, DYED DIESEL FUEL, NONTAXABLE USE ONLY, PN. PENALTY FOR TAXABLE USE FUEL OIL, 3, NA1993, PG III 137	2200 ** 2200	2172 ** 2172	88.1/033.6	Meter 19 Preset 2200 Code 07 100.0%
NO2 LOW SULFUR, .05% MAX SULFUR, 40 CETANE MIN, DYED DIESEL FUEL, NONTAXABLE USE ONLY, PN. PENALTY FOR TAXABLE USE FUEL OIL, 3, NA1993, PG III 137	2800 ** 2800	2764 ** 2764	88.3/033.6	Meter 19 Preset 2800 Code 07 100.0%
NO2 LOW SULFUR, .05% MAX SULFUR, 40 CETANE MIN, DYED DIESEL FUEL, NONTAXABLE USE ONLY, PN. PENALTY FOR TAXABLE USE FUEL OIL, 3, NA1993, PG III 137	520 ** 520	513 ** 513	88.2/033.6	Meter 19 Preset 520 Code 07 100.0%
		5449		

CONV GASOLINE / 7.8 RVP GASOLINE / CLEAR L.S. #2 / DYED L.S. #2 / U.S. #2

(** - Batch Total)

Attachment 5

Description of Stack Sampling Facilities
Proposed Natural Gas Fueled Engine Driven Pumps
Proposed Emergency Generator

Alexander Orr, Jr.
Water Treatment Plant

Description of Stack Sampling Facilities

Alexander Orr, Jr. Water Treatment Plant
Miami-Dade Water and Sewer Department

Proposed Natural Gas Fueled Engine Driven Pumps

Diameter (in.):	12 inches (Engine Nos. 3 and 4) 18 inches (Engine No. 5)
Orientation:	Vertical
Height above structure (ft):	3.5 feet
Height above grade (ft):	32 feet
Means of access:	Portable ladder or man lift
Sampling ports:	Standard sampling ports are provided in the exhaust piping inside the East Pump Room building.

Proposed Emergency Generator

Diameter (in.):	8 inches
Orientation:	Horizontal
Height above structure (ft):	6 feet
Height above grade (ft):	18 feet
Means of access:	Portable ladder or man lift to roof.
Sampling ports:	No sampling ports are feasible given configuration. Alternate sampling procedure requested. Sampling accomplished through use of a rake probe is inserted into end of stack.

Attachment 6

Procedures for Startup

Alexander Orr, Jr.
Water Treatment Plant

Procedures for Startup
Engine Driven Pumps
Alexander Orr, Jr. Water Treatment Plant
Miami-Dade Water and Sewer Department

Normal Startup

The engine driven pumps at the Alexander Orr, Jr. WTP are started by air power. Prior to start up the starting air cylinders and compressors will be checked for adequate air supply and operation. The engine and drive gear operating fluid levels will be checked with additions made as necessary. Engine cooling water, fuel supply, starting air supply valves and pump suction valves will be aligned to the proper condition for startup. Start engine auxiliary pumps and pre-lubrication pumps if supplied. Open priming water supply valves, verify priming water supply to the main pump. To begin startup, the starting air is applied to the air motor, once the engine begins to turn over, the spark ignition will begin. After ignition, shut off the starting air, along with the engine pre-lubrication pump. The engine will be running at idle setting. Since the pump is directly coupled through the drive gears to the engine, the pump will be engaged. Let engine run for 2 to 3 minutes before putting the pump on the line. Actuate the cone valve and observe the valve open. (The pointer that indicates open or closed position is on the side of the cone valve.) After the cone valve is open and the engine loaded, shut off the main pump priming water supply. Check engine, gauges and auxiliaries to make sure there are no leaks, etc. Monitor engine exhaust and operating parameters for any abnormalities that would require shut down. Following operations at minimum speed to allow the engine to reach minimum operating temperatures, the engine speed may be increased as required. Adjust engine speed to desired operating range. The pump engines will be operating under load within 3 minutes of startup and approximately 15 minutes to before a full load is applied.

Excess Emissions

Excess emissions that occur during startup will consist of elevated hydrocarbon (HC), carbon monoxide (CO), and particulate (PM) emissions as a result of cold combustion temperatures. As the pump engine warms up and additional load, emissions of these pollutants will decrease. Emissions of nitrogen oxides (NOx) will increase as the engines warm up and reaches a fully loaded condition.

Since limitations in the permit application are based on the consumption of fuel, emissions resulting from startup of the pump engines are accounted for in monitoring, recordkeeping, and reporting.

Do not attempt to remove the valve covers when the engine is operating. The transformers are grounded to the valve covers. Personal injury or death may result and the ignition system will be damaged if the valve covers are removed during engine operation. The engine will not operate without the valve covers.

i00659904

Before Starting Engine

SMCS Code: 1000

Inspect the engine for potential hazards.

Before starting the engine, ensure that no one is on, underneath, or close to the engine. Ensure that the area is free of personnel.

Ensure that the engine is equipped with a lighting system that is suitable for the conditions. Ensure that all lights work properly.

All protective guards and all protective covers must be installed if the engine must be started in order to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

Do not bypass the automatic shutoff circuits. Do not disable the automatic shutoff circuits. The circuits are provided in order to help prevent personal injury. The circuits are also provided in order to help prevent engine damage.

On the initial start-up of a new engine or an engine that has been serviced, be prepared to stop the engine if an overspeed condition occurs. This may be accomplished by shutting off the fuel supply to the engine, or shutting off the ignition system.

See the Service Manual for repairs and for adjustments.

i00572000

Engine Starting

SMCS Code: 1000

If a warning tag is attached to the engine start switch or to the controls, DO NOT start the engine or move the controls. Consult with the person that attached the warning tag before the engine is started.

All protective guards and all protective covers must be installed if the engine must be started in order to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

Start the engine from the operator's compartment or from the engine start switch.

Always start the engine according to the procedure that is described in the Operation and Maintenance Manual, "Engine Starting" topic in the Operation Section. Knowing the correct procedure will help to prevent major damage to the engine components. Knowing the procedure will also help to prevent personal injury.

To ensure that the jacket water heater (if equipped) and/or the lube oil heater (if equipped) is working properly, check the water temperature gauge and the oil temperature gauge during the heater operation.

Engine exhaust contains products of combustion which can be harmful to your health. Always start the engine and operate the engine in a well ventilated area. If the engine is started in an enclosed area, vent the engine exhaust to the outside.

i00659907

Engine Stopping

SMCS Code: 1000

To avoid overheating of the engine and accelerated wear of the engine components, stop the engine according to the instructions in this Operation and Maintenance Manual, "Engine Stopping" topic (Operation Section).

Use the Emergency Stop Button (if equipped) ONLY in an emergency situation. Do not use the Emergency Stop Button for normal engine stopping. After an emergency stop, DO NOT start the engine until the problem that caused the emergency stop has been corrected.

On the initial start-up of a new engine or an engine that has been serviced, make provisions to stop the engine if an overspeed occurs. This may be accomplished by shutting off the fuel supply to the engine, or shutting off the ignition system.

Engine Starting

i01071463

Before Starting Engine

SMCS Code: 1000

Note: Certain procedures are required before an engine is started for the first time. See Special Instruction, SEHS9769, "Installation and Initial Start-UP Procedure for G3500 Engines".

Perform the required daily maintenance and other periodic maintenance before starting the engine. This can prevent major repairs at a later date. See this Operation and Maintenance Manual, "Maintenance Interval Schedule" (Maintenance Section).

Walk-Around Inspection

NOTICE

For any type of leak, clean up the fluid. If leaking is observed, find the source and correct the leak. If leaking is suspected, check the fluid levels more often than recommended until the leak is found or fixed, or until the suspicion of a leak is proved to be unwarranted.

To obtain maximum service life for your engine, make a thorough inspection before starting the engine. Make a walk-around inspection of the installation. Look for items such as oil or coolant leaks, loose bolts and trash buildup. Remove any trash. Make repairs, if necessary.

- The guards must be in the proper place. Repair damaged guards or replace missing guards.
- Ensure that the areas around the rotating parts are clear.

Air Inlet System

- Ensure that the air inlet piping and the air filters are in place.
- Ensure that all clamps and connections are secure.
- Inspect the air cleaner service indicator (if equipped). Service the air cleaner filter element when the yellow diaphragm enters the red zone, or the red piston locks in the visible position.

Cooling System

- Inspect the cooling system for leaks or loose connections. Inspect the condition of all the hoses and pipes for the cooling system. Ensure that the connections are properly clamped.
- Inspect the water pumps for evidence of leaks.
- Check the coolant level. Add coolant, if necessary. For information on the proper coolant to use, see this Operation and Maintenance Manual, "Cooling System Specifications" (Maintenance Section).

Driven Equipment

- If necessary, check the oil levels of the driven equipment. Perform any maintenance that is required for the driven equipment. Refer to the literature that is provided by the OEM of the driven equipment.
- If the engine is equipped with a clutch, ensure that the clutch is disengaged.
- For generator set engines, ensure that the main circuit breaker is open.

Electrical System

Inspect the wiring for the following conditions:

- Loose connections
- Wiring that is worn or frayed

Inspect the gauge panel and the control panel for good condition. Reset any shutoff or alarm components.

Fuel System

⚠ WARNING

NEVER use a flame to check for gas leaks. Use a gas detector.

An open flame can ignite mixtures of air and fuel. This will cause explosion and/or fire which could result in severe personal injury or death.

- Check the fuel lines for leaks with a gas detector.
- Inspect the fuel lines for loose fittings and leaks. Ensure that the fuel lines are properly clamped.
- Ensure that the fuel is supplied to the engine at the correct pressure for the engine.

Lubrication System

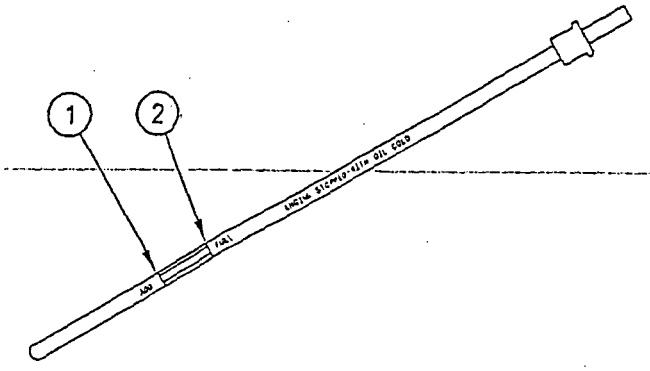


Illustration 33 g00274899

Oil level gauge (dipstick)

(1) "ADD" mark
(2) "FULL" mark

NOTICE
Excessive engine oil will increase oil consumption and result in excessive deposits in the combustion chamber. Do not overfill the engine with oil.

- Check the engine crankcase oil level. Maintain the oil level between the "ADD" and "FULL" marks on the "ENGINE STOPPED WITH OIL COLD" side of the oil level gauge. For information on the proper oil to use, see this Operation and Maintenance Manual, "Lubricant Specifications" (Maintenance Section).
- Check for leaks at the following components: crankshaft seals, crankcase, oil filters, oil gallery plugs, sensors, and valve covers.
- Inspect the tubes, tee pieces, and clamps on the crankcase breathers.

Starting System

Note: If the engine is equipped with a system for external support, prepare the system before starting the engine. Ensure that all of the systems for engine support are enabled. Perform all prestart checks for the control system.

Air Starting Motor

- Drain moisture and sediment from the air tank and from any other air piping.
- Check the oil level in the lubricator. Keep the lubricator at least half full. Add oil, if necessary. For temperatures above 0 °C (32 °F), use a nondetergent 10W oil. For temperatures below 0 °C (32 °F), use air tool oil.
- Check the air pressure for starting. The air starting motor requires a minimum of 690 kPa (100 psi). The maximum allowable air pressure is 1030 kPa (150 psi). Open the air supply valve.

Electric Starting Motor

- Disconnect any battery chargers that are not protected against the high current drain that is created when the electric starting motor engages.

Inspect the wiring, the electrical cables, and the battery for the following conditions:

- Loose connections
- Wires that are worn or frayed
- Corrosion

i00719534

Cold Weather Starting

SMCS Code: 1000; 1250

Note: Oil pan immersion heaters are not recommended for heating the lube oil. To ensure the compatibility of the components, only use equipment that is recommended by Caterpillar.

Startability will be improved at temperatures below 16 °C (60 °F) with a starting aid. A jacket water heater may be needed and/or the crankcase oil may need to be warmed.

A jacket water heater is available as an option for starting in temperatures as low as 0 °C (32 °F). The jacket water heater can maintain the water temperature at approximately 32 °C (90 °F). The heated water will help to keep the oil in the engine block warm enough to flow when the engine is started.

To start the engine at colder temperatures, a larger volume of starting air and/or a higher air pressure may be necessary.

For electric starting, extra battery capacity may be necessary.

Consult your Caterpillar dealer for more information on the starting aids that are available for cold weather starting.

i00758716

Starting the Engine

SMCS Code: 1000

⚠ WARNING

Engine exhaust contains products of combustion which may be harmful to your health. Always start and operate the engine in a well ventilated area and, if in an enclosed area, vent the exhaust to the outside.

NOTICE

For initial start-up of a new or rebuilt engine, and for start-up of an engine that has been serviced, make provision to shut the engine off should an overspeed occur. This may be accomplished by shutting off the fuel supply and/or the ignition to the engine.

Note: Using the "EMERGENCY STOP" button will shut off both the fuel and the ignition.

⚠ WARNING

Unburned gas in the inlet manifold can ignite when the engine is started. Personal injury and/or property damage can result. Clear the engine and the exhaust system of unburned gas

Before starting an engine that was stopped by terminating the ignition system, turn the gas supply OFF. Crank the engine for approximately 15 seconds in order to clear any unburned gas from the engine and the exhaust system.

Do not start the engine or move any of the controls if there is a "DO NOT OPERATE" warning tag or similar warning tag attached to the start switch or to the controls.

Ensure that no one will be endangered before the engine is started and when the engine is started.

Perform the procedures that are described in this Operation and Maintenance Manual, "Before Starting Engine" (Operation Section).

Operation of the Generator Set Control Panel

For information on operation for a specific generator set control panel, refer to the Operation and Maintenance Manual for the generator and the control panel.

Automatic Starting

⚠ WARNING

When the engine is in the AUTOMATIC mode, the engine can start at any moment. To avoid personal injury, always remain clear of the the engine when the engine is in the AUTOMATIC mode.

If the engine control switch is in the "AUTO" position, the engine will automatically start when the remote start/stop initiate contact closes. The engine will accelerate to rated rpm when the oil pressure is sufficient.

Manual Starting

1. Ensure that fuel is supplied to the engine. Ensure that no gas is leaking.
2. Ensure that the driven equipment is unloaded.
   a. For generator set engines, ensure that the main circuit breaker is open.
   b. For industrial engines, unload the compressor or pump. Disengage the clutch (if equipped). Place the transmission and/or other attachments for the power take-off in NEUTRAL.

Note: Before starting an industrial engine, move the governor control lever to the position for 1/2 of rated rpm.

NOTICE

Do not engage the starting motor when flywheel is turning. Do not start the engine under load.

If the engine fails to start within 30 seconds, release the starter switch or button and wait two minutes to allow the starting motor to cool before using it again.

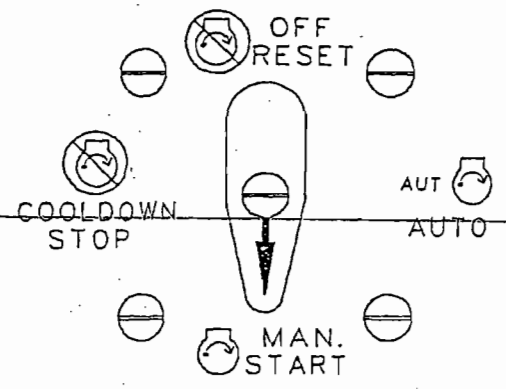


Illustration 34 g00319402

Engine control switch in the "Man. Start" position

3. Turn the engine control switch to the "Man. Start" position in order to start the engine.

Note: After starting an industrial engine, move the governor control lever to the position for low idle rpm.

4. Allow the engine to idle for three to five minutes. The engine speed should stabilize at low idle rpm. Check all of the pressure gauges. Inspect the engine for leaks and listen for unusual noises. When all systems are normal, the rpm may be increased.

Table 12

Rated RPM And Low Idle RPM					
Rated rpm	1000	1200	1400	1500	1800
Low idle rpm	700	900	1000	1000	1200

Starting Failure

Note: If the cycle crank feature is enabled, the Status Control Module (SCM) will attempt to start the engine for the programmed period. If the engine fails to start within the programmed period, the SCM will execute an overcrank fault. The "OVERCRANK" indicator on the Remote Control Panel (Status) will illuminate. The SCM must be reset before the engine can be started. Turn the engine control switch to the "OFF/RESET" position.

If the engine fails to start after cranking for 30 seconds, stop cranking. Perform the following procedure:

1. Turn the engine control switch to the "OFF/RESET" position.

2. Turn the gas supply OFF.

3. Allow the starting motor to cool for two minutes. Crank the engine for approximately 15 seconds in order to disperse any unburned gas from the engine and the exhaust system.

4. Allow the starting motor to cool for two minutes. Turn the gas supply ON. Repeat the starting procedure.

i01037941

Starting with Jump Start Cables

SMCS Code: 1000; 1401; 1402

⚠ WARNING

Improper jump start cable connections can cause an explosion resulting in personal injury.

Prevent sparks near the batteries. Sparks could cause vapors to explode. Do not allow jump start cable ends to contact each other or the engine.

If the installation is not equipped with a backup battery system, it may be necessary to start the engine from an external electrical source.

First, determine the reason that it is necessary to start with power from an external source. Refer to Special Instruction, SEHS7768, "Use of the 6V-2150 Starting/Charging Analyzer".

Many batteries which are considered unusable are still rechargeable. After jump starting, the alternator may not be able to fully recharge batteries that are severely discharged. The batteries must be charged to the proper voltage with a battery charger. For information on testing and charging, refer to the Special Instruction, SEHS7633, "Battery Test Procedure".

Attachment 7

Proposed Replacements
Engine Driven Pumps Nos. 3 & 4
G3512LE Technical Data

G3512LE Performance Data
G3512LE Emissions
G3500 Engine Basics
G3500 Ignition Systems

Alexander Orr, Jr.
Water Treatment Plant

G3512LE

PERFORMANCE DATA

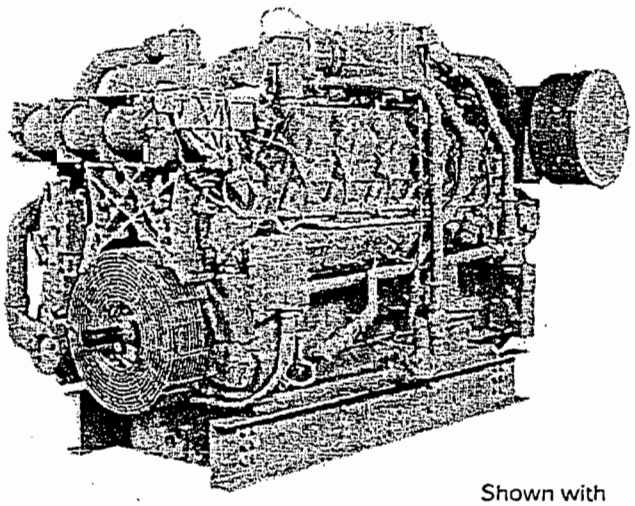
CATERPILLAR®

Gas Industrial Engine

G3512

525-1005 hp

Standard and Low Emission



Shown with Optional Equipment

SPECIFICATIONS

V-12, 4-Stroke-Cycle, Spark Ignited

Bore—in (mm)	6.7 (170)
Stroke—in (mm)	7.5 (190)
Displacement—cu in (L)	3158 (51.8)
Compression Ratio	
STD	9:1
LE	8:1
Aspiration	Naturally Aspirated or Turbocharged-Aftercooled
Lube Oil Capacity — gal (L)	
STD*	116 (493)
STD**	128 (483)
LE	81 (307)
Jacket Water System — gal (L)	
Capacity w/o Radiator	39 (148)

* Oil fill capacity with 14 elements
** Oil fill capacity without elements

CATERPILLAR ENGINE FACILITIES ISO 9001 CERTIFIED

FEATURES

■ DIESEL STRENGTH

All Caterpillar® gas engines are built on diesel frames which means greater service life. Caterpillar gas engines inherit more from their diesel counterparts than just strength. They are backed by the same support system recognized as one of the most sophisticated and dependable in the world.

■ APPLICATION FLEXIBILITY

Broad operating speed range and ability to burn a wide spectrum of gaseous fuels.

■ LOW EMISSIONS

Low emission engines are capable of NO(x) levels as low as 2.0 grams/hp-hr. Lower emissions may be achievable for selected applications. Consult your Caterpillar dealer.

■ CATERPILLAR® GAS ENGINES

Represent the latest technology in engine design. Engines are offered in both naturally aspirated and turbocharged/aftercooled configurations.

TA is offered as standard and low emission. These different configurations offer:

- High energy ignition systems for consistent firing
- High efficient combustion chamber for complete burning of the fuel.
- Modern component design such as deep cup, oil gallery piston

■ ELECTRONIC IGNITION SYSTEM WITH DETONATION SENSITIVE TIMING

The Caterpillar electronic ignition system provides optimized spark timing for all operating conditions. Timing is automatically controlled to maintain continuous detonation protection.

CATERPILLAR®

G3512 GAS INDUSTRIAL ENGINE

STANDARD EQUIPMENT

Air cleaners
  single stage, dry, with service indicator
Breather, crankcase
Carburetor
  natural gas
Cooler
  lubricating oil
Filter
  lubricating oil, RH
Flywheel housing
  SAE No. 00
Governor
  Woodward
Ignition system
  Altronic III or Caterpillar E.I.S.
Instrument panel, RH
  8 gauge panel (STD)
  12 gauge panel (LE)
  oil pressure
  coolant temperature
  oil pressure differential
  intake manifold temp (TA only)
  pressure (LE)
  service meter
  exhaust pyrometer (LE)
Lifting eyes
Manifold, exhaust
  watercooled
Pumps, gear driven
  aftercooler water (TA only)
  jacket water
Rails, mounting, 10 in.
Regulator, gas pressure
SAE standard rotation
Thermostats and housing
Torsional vibration damper

OPTIONAL EQUIPMENT

Air to air aftercooler connection
Air head for 3161
Cooling systems
  high temp (LE only)
CSA ignition
Exhaust fittings
Low pressure gas conversion
Muffler
Power takeoffs
Starting systems
Tachometer

CONTINUOUS RATINGS (BHP)

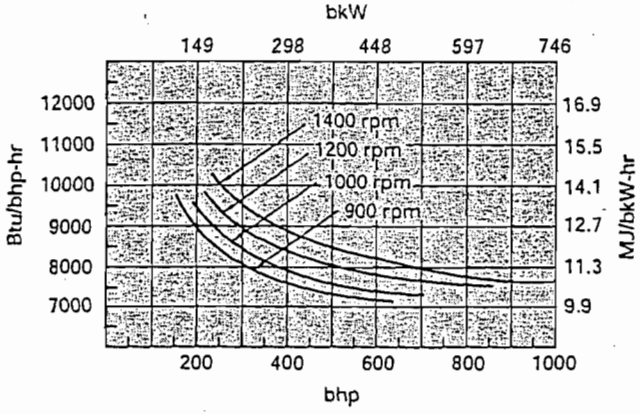
Aspiration	1400 rpm	1300 rpm	1200 rpm	1100 rpm	1000 rpm	900 rpm
LE-90, 8:1	1005	930	860	790	720	650
LE-130, 8:1	945	875	810	740	675	610
STD TA-90, 9:1	–	–	815	745	675	610
STD TA-130, 9:1	–	–	790	725	660	595
STD NA, 9:1	–	–	525	480	440	395

PHYSICAL FACTORS

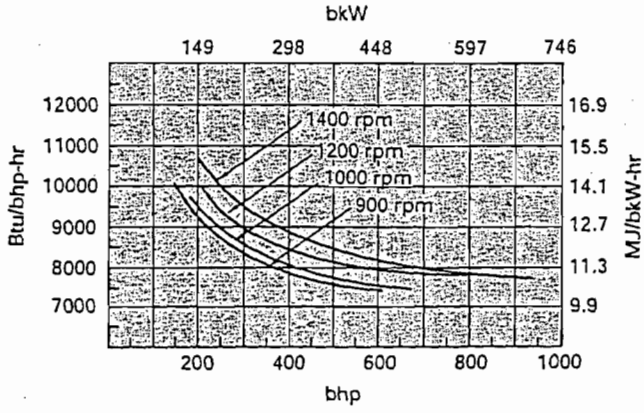
	Height in (mm)	Width in (mm)	Length in (mm)	Weight lb (kg)
LE	73.4 (1863)	67.1 (1703)	110 (2788)	14 650 (6651)
STD TA	73.4 (1863)	67.1 (1703)	110 (2788)	14 450 (6560)
STD NA	75.2 (1911)	64.7 (1642)	105 (2671)	13 400 (6084)

FUEL CONSUMPTION

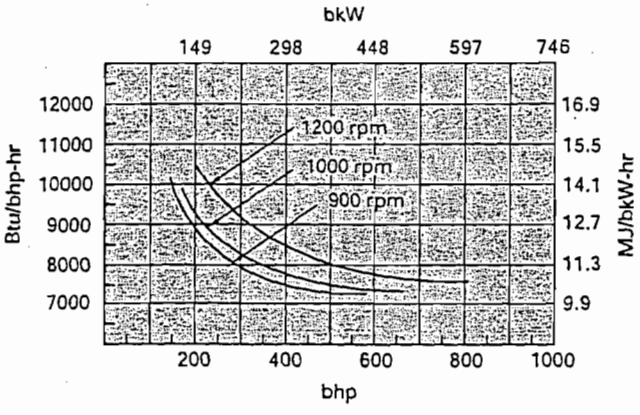
LE-90



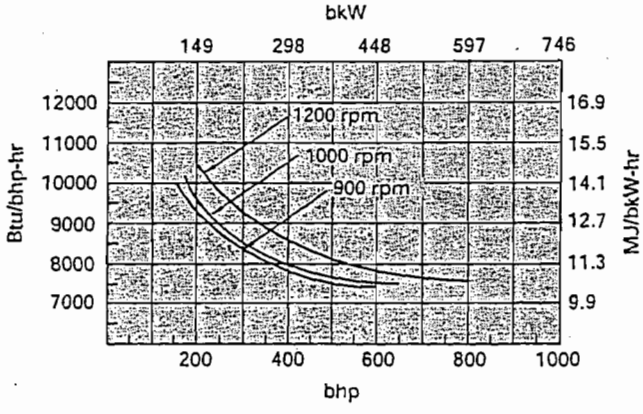
LE-130



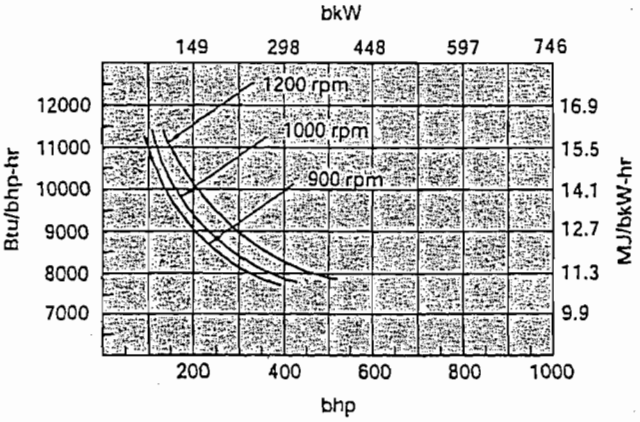
STD TA-90



STD TA-130



STD NA

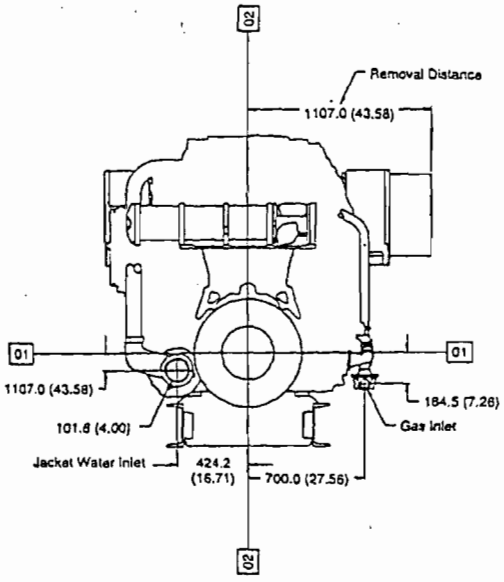


LE refers to low emission engine configuration.
STD refers to standard engine configuration.
90 refers to aftercooler water inlet temperature in 90° F (32° C).
130 refers to aftercooler water inlet temperature in 130° F (54° C).
All data is based on standard conditions. 77° F (25° C) 500 ft Alt.
These ratings do not allow for overload capability.

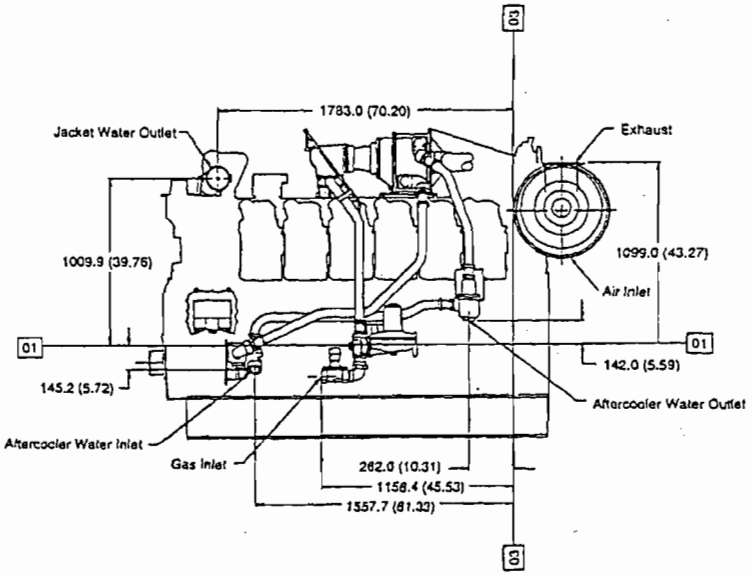
CATERPILLAR®

G3512 GAS INDUSTRIAL ENGINE

GAS INDUSTRIAL ENGINE



FRONT VIEW



LEFT SIDE VIEW

01 Centerline of Crankshaft

02 Centerline of Engine

03 Rear face of Cylinder Block

See general dimension drawing 119-9598 for additional Electronic Ignition System (E.I.S.) engine detail and NA information.

For magneto ignition system engines see general dimension drawing 7W-4444.

Note: General configuration not to be used for installation.

CONDITIONS AND DEFINITIONS

Ratings are based on SAE J1349 standard conditions of 29.61 in Hg (100 kPa) and 77 ° F (25° C). These ratings also apply at ISO3046, DIN6271, and BS5514 standard conditions of 29.61 in Hg (100 kPa), 81 ° F (27° C); and API 7B-11C standard conditions of 29.38 in Hg (99 kPa), 85° F (29° C).

Ratings are based on dry natural gas having a low heat value of 905 btu/ft³ (35.54 MJ/N m³). Variations in altitude, temperature, and gas composition from standard conditions may require a reduction in engine horsepower; contact your Caterpillar dealer.

Turbocharged-aftercooled ratings apply to 5000 ft (1525 m) and 77 ° F (25° C). **Naturally aspirated** engines apply to 500 ft (150 m) and 77° F (25° C). For applications which exceed these limits, consult your Caterpillar dealer.

Additional ratings may be available for specific customer requirements. Consult your Caterpillar representative for details.

LEHQ6162 (3-96)
Supersedes LEHH0573

G3512LE

APPLICATION & INSTALLATION GUIDE

CATERPILLAR®

Caterpillar Inc.
9701 State Road 26 East
Lafayette, IN 47905-4356

14 June 2000

Gas Engine Emissions Letter

PROJECT:	MDWASD Alexander WTP	BSFC:	7407 BTU/bhp-hr
model:	GS512	fuel pressure:	45 psi
compression ratio:	8:1	fuel LHV:	963 btu/ft3
A/C inlet temp:	130 ° F	fuel MN:	72.7
J/W outlet temp:	210 ° F	site altitude:	sea lvl ft
rating:	810 bhp @	max. ambient	110 ° F
	1200 rpm	timing	31 ° BTDC

		100%
Engine Power	bhp	810
Exhaust O2	%	8.30
NOx (as NO2)	g/bhp-hr	2.00
	tons/year	15.64
CO	g/bhp-hr	1.60
	tons/year	12.51
total HC	g/bhp-hr	3.10
	tons/year	24.25
non-methane HC	g/bhp-hr	0.50
	tons/year	3.91
NMNEHC	g/bhp-hr	0.50
	tons/year	3.91
Formaldehydes	g/bhp-hr	0.27
	tons/year	2.11
PM10	lbs/bhp-hr	0.30

Emission levels are based on engine operation under steady state conditions, adjusted to the specified NOx level at 100% load. The CO, total HC, and non-methane HC values listed are 20% higher than nominal levels to allow for instrumentation, measurement, and engine-to-engine variations; these values indicate "not to exceed" levels. Tons per year values are based on 8,760 hours of operation per year. This information is valid for engine orders placed within six months of the above date. Please contact the factory if an extension of this period is required.

Sincerely,

Jeffery A. Elijah

Applications Engineer
Technical/Commercial Services
Petroleum Business Unit

Appd: Performance Engineer

Jayson Wagler

Technical Manager

Robert Mazzon

Engine Speed (rpm)	1200	Fuel	NAT GAS
Compression Ratio	8:1	LHV of Fuel (Btu/SCF)	920
Aftercooler Inlet Temperature (°F)	130	Fuel System	HPG IMPCO
Jacket Water Outlet Temperature (°F)	210		
Ignition System	EIS	Minimum Fuel Pressure (psig)	35
Exhaust Manifold	WATER COOLED	Methane Number at Conditions Shown	80
Combustion System Type	LOW EMISSION	Rated Altitude (ft)	5000
		at 77°F Design Temperature	

Engine Rating Data	% Load	100%	75%	50%
Engine Power (w/o fan)	bhp	810	607	405
Engine Data				
Specific Fuel Consumption (BSFC) (1)	Btu/bhp-hr	7407	7600	7937
Air Flow (Wet, @ 77°F, 28.8 in Hg)	SCFM	1668	1209	827
Air Mass Flow (Wet)	lb/hr	7395	5362	3665
Compressor Out Pressure	in. HG (abs)	69.6	62.2	46.5
Compressor Out Temperature	°F	289	261	186
Inlet Manifold Pressure	in. HG (abs)	60.8	45.9	32.3
Inlet Manifold Temperature (10)	°F	138	134	134
Timing (11)	°BTDC	33	33	33
Exhaust Stack Temperature	°F	801	786	777
Exhaust Gas Flow (Wet, @ stack temperature, 29.7 in Hg)	CFM	4260	3060	2080
Exhaust Gas Mass Flow (Wet)	lb/hr	7683	5584	3823
Engine Emissions Data				
Nitrous Oxides (NOx as NO2) (9)	g/bhp-hr	2.0	3.3	3.3
(Corr. 15% 02)	ppm	124	245	231
Carbon Monoxide (CO) (9)	g/bhp-hr	1.6	1.7	1.9
(Corr. 15% 02)	ppm	195	212	215
Total Hydrocarbons (THC) (9)	g/bhp-hr	3.1	2.8	3.2
(Corr. 15% 02)	ppm	678	604	644
Non-Methane Hydrocarbons (NMHC) (9)	g/bhp-hr	0.47	0.42	0.48
(Corr. 15% 02)	ppm	48	40	41
Exhaust Oxygen (9)	%	8.2	7.4	7.0
Lambda		1.58	1.49	1.43
Engine Heat Balance Data				
Input Energy LHV (1)	Btu/min	99992	76948	53571
Work Output	Btu/min	34365	25774	17183
Heat Rejection to Jacket (2) (6)	Btu/min	31421	26759	20465
Heat Rejection to Atmosphere (Radiated) (4)	Btu/min	3643	3036	2429
Heat Rejection to Lube Oil (5)	Btu/min	0	0	0
Total Heat Rejection to Exhaust (to 77°F) (2)	Btu/min	25965	18499	12609
Heat Rejection to Exhaust (LHV to 350°F) (2)	Btu/min	15457	10904	7330
Heat Rejection to Aftercooler (3) (7) (8)	Btu/min	4598	2880	885

Engine Noise Data - at 100% load

Noise - Mechanical @ 1 m	100	dB(A)
Noise - Exhaust @ 1.5 m	111	dB(A)

Fuel Usage Guide

Derate Factor / Engine Timing vs Methane Number

<30	30	35	40	45	50	55	60	65	70	75	80
0/--	0.90/19	0.90/21	0.90/22	1.0/23	1.0/24	1.0/26	1.0/27	1.0/28	1.0/30	1.0/31	1.0/32

Altitude Deration Factors

AIR INLET TEMP. (°F)	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
130	1.00	1.00	1.00	0.98	0.94	0.91	0.88	0.84	0.81	0.78	0.75	0.72	0.70
120	1.00	1.00	1.00	1.00	0.96	0.93	0.89	0.86	0.83	0.80	0.77	0.74	0.71
110	1.00	1.00	1.00	1.00	0.98	0.94	0.91	0.87	0.84	0.81	0.78	0.75	0.72
100	1.00	1.00	1.00	1.00	1.00	0.96	0.92	0.89	0.86	0.82	0.79	0.76	0.73
90	1.00	1.00	1.00	1.00	1.00	0.98	0.94	0.91	0.87	0.84	0.81	0.78	0.75
80	1.00	1.00	1.00	1.00	1.00	0.99	0.96	0.92	0.89	0.85	0.82	0.79	0.76
70	1.00	1.00	1.00	1.00	1.00	1.00	0.98	0.94	0.90	0.87	0.84	0.81	0.77
60	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.96	0.92	0.89	0.85	0.82	0.79
50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	0.94	0.90	0.87	0.84	0.80

ALTITUDE (FEET ABOVE SEA LEVEL)

Aftercooler Heat Rejection Factors

AIR INLET TEMP. (°F)	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
130	1.38	1.45	1.52	1.59	1.67	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74
120	1.29	1.36	1.43	1.50	1.57	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64
110	1.20	1.27	1.33	1.40	1.47	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54
100	1.11	1.17	1.24	1.31	1.38	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45
90	1.02	1.08	1.15	1.21	1.28	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35
80	1.00	1.00	1.05	1.12	1.18	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
70	1.00	1.00	1.00	1.02	1.09	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
60	1.00	1.00	1.00	1.00	1.00	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06
50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

ALTITUDE (FEET ABOVE SEA LEVEL)

DM0150-03 Data is intended to be used with Gas Engine Performance Book Parameters – DM5900-00 on page 8

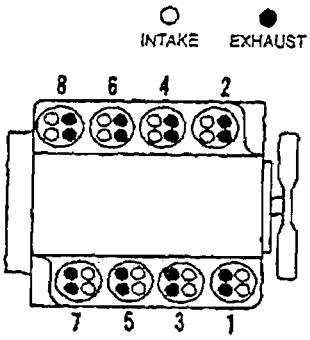
CATERPILLAR®

G3500 Engine Basics

8-97

Engine Design

G3508



Cylinder And Valve Location

Number And Arrangement Of Cylinders.....V–8

Valves Per Cylinder.....4

Bore.....170 mm (6.7 in)

Stroke.....190 mm (7.5 in)

Compression Ratio.....refer to nameplate on engine

Type Of Combustion.....spark ignited

Crankshaft Rotation (as viewed from flywheel end).....counterclockwise

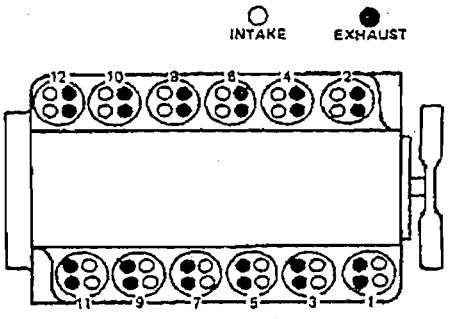
Firing Order.....1-2-7-3-4-5-6-8

Compression Ratios Available.....8.1:1, 9.1:1, 11.0:1

Valve Setting
- Inlet.....0.51 mm (.020 in)
- Exhaust.....1.27 mm (.050 in)

Note: Front of engine is opposite flywheel end. Left and right side of engine are as seen from flywheel end. No. 1 cylinder is front cylinder on right side. No. 2 cylinder is front cylinder on left side.

G3512



Cylinder And Valve Location

Number And Arrangement Of Cylinders.....V–12

Valves Per Cylinder.....4

Bore.....170 mm (6.7 in)

Stroke.....190 mm (7.5 in)

Compression Ratio.....refer to nameplate on engine

Type Of Combustion.....spark ignited

Crankshaft Rotation (as viewed from flywheel end).....counterclockwise

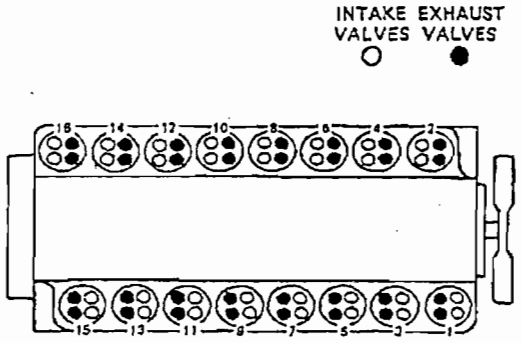
Firing Order.....1-12-9-4-5-8-11-2-3-10-7-6

Compression Ratios Available.....8.1:1, 9.1:1, 11.0:1, 12.0:1

Valve Setting
- Inlet.....0.51 mm (.020 in)
- Exhaust.....1.27 mm (.050 in)

Note: Front of engine is opposite flywheel end. Left and right side of engine are as seen from flywheel end. No. 1 cylinder is front cylinder on right side. No. 2 cylinder is front cylinder on left side.

G3516



Cylinder And Valve Location

Number And Arrangement Of Cylinders.....V–16

Valves Per Cylinder 4

Bore .....170 mm (6.7 in)

Stroke.....190 mm (7.5 in)

Compression Ratio.....refer to nameplate on engine

Type Of Combustion.....spark ignited

Crankshaft Rotation (as viewed from flywheel end) .....counterclockwise

Firing Order 1-2-5-6-3-4-9-10-15-16-11-12-13-14-7-8

Compression Ratios Available 8.1:1, 9.1:1, 11.0:1, 12.0:1

Valve Setting
- Inlet.....0.51 mm (.020 in)
- Exhaust .....1.27 mm (.050 in)

Note: Front of engine is opposite flywheel end. Left and right side of engine are as seen from flywheel end. No. 1 cylinder is front cylinder on right side. No. 2 cylinder is front cylinder on left side.

Electronic Ignition System (EIS)

The Caterpillar Electronic Ignition System (EIS) is designed to replace the traditional magneto ignition system. The Electronic Ignition System eliminates the magneto and other components that were subject to mechanical wear. It also provides increased engine diagnostic and troubleshooting capabilities.

The Electronic Ignition System (Figures 1) uses one control module (4) to handle many applications and many engine types. This is achieved by allowing the operator to change key parameters "on-sight". These programmable parameters are referred to as Customer Specified Parameters and may be set or changed using the Digital Diagnostic Tool (DDT). The values programmed into the system are stored in the EIS Control Module memory. This allows the operator to tailor the ignition system operation with a single service tool.

The DDT (Digital Diagnostic Tool) service tool is used to program Customer Specified Parameters, monitor engine functions, and display engine diagnostics. The DDT can monitor engine speed, engine timing and detonation levels.

For additional information on programming parameters and troubleshooting diagnostic codes, refer to Electronic Troubleshooting, G3500 Engines, SENR6413.

The EIS control module also has the ability to diagnose and store system problems and potential transformer secondary circuit problems. When a problem is detected, a diagnostic code is generated and can be displayed on the DDT.

The EIS system monitors engine operation and distributes power to the cylinder transformers, to provide the best engine performance at all engine speeds. It also protects the engine from damage caused by

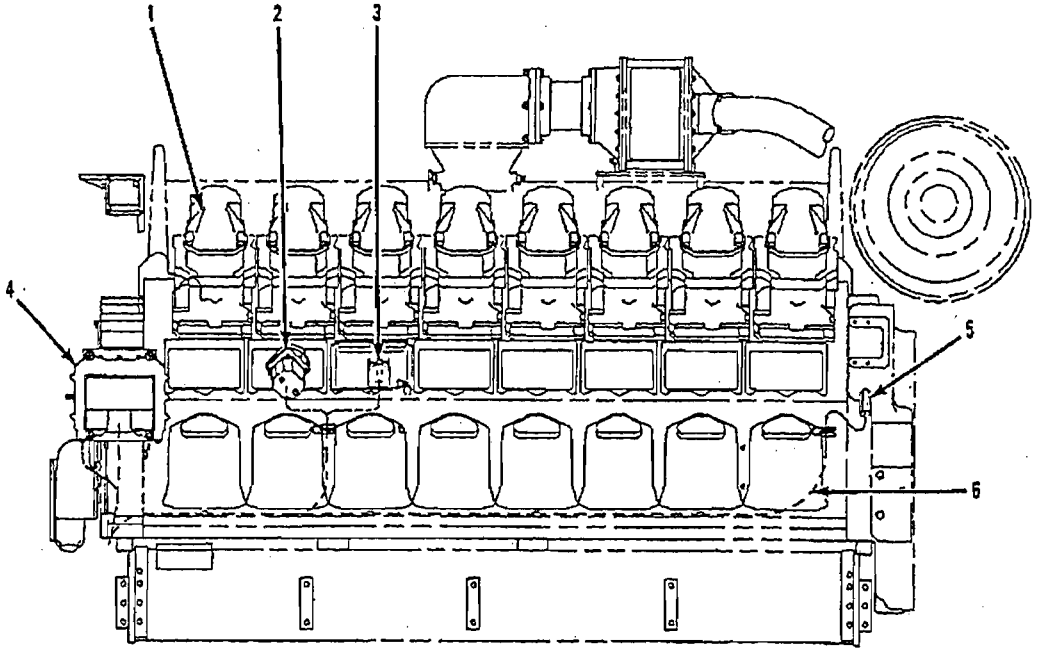


Figure 1. Component Location
(1) Ignition transformer (under valve cover). (2) Manifold air pressure sensor. (3) Detonation sensor.
(4) Electronic Ignition System control module. (5) Speed/Timing sensor. (6) Wiring harness for Speed/Timing sensor (internal).

detonation. Within specified limits, control of engine timing (retarding) is infinitely variable.

The Electronic Ignition System (Figure 3) provides detonation protection and precision spark control for each cylinder. Detonation is controlled as it occurs and timing is retarded only as much and as long as necessary to prevent engine damage. The EIS system allows improved operation, economy and lower emission levels. The system consists of three basic groups: the control module, ignition transformers(2) and sensors.

EIS Control Module

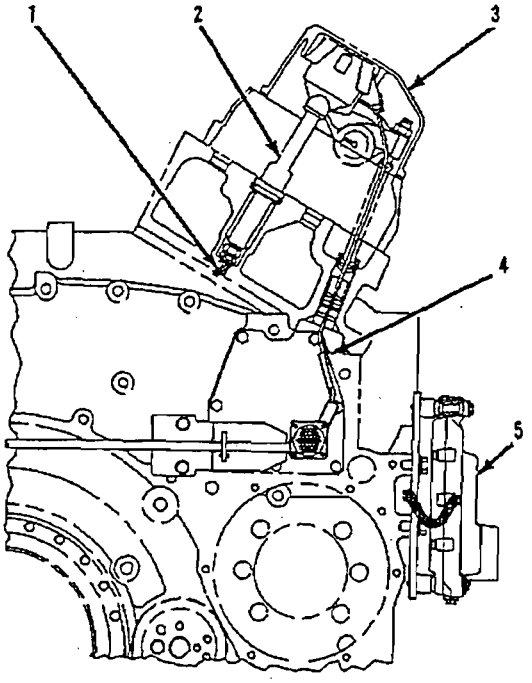


Figure 2. Ignition System Components
(1) Spark plug. (2) Ignition transformer. (3) Valve cover. (4) Wiring harness. (5) Electronic Ignition System control module.

The EIS Control Module (5) is a sealed unit with no serviceable parts (Figure 2). The control module monitors engine operation through a series of sensors. The sensors are connected to the module through wiring harnesses (4) routed inside the engine block. The control module uses input from the sensors and the control panel settings to determine ignition timing. The control module provides system diagnostics and also supplies voltage to the ignition transformers (2) which step up the voltage to fire the spark plugs (1). The valve cover (3) acts as a ground for the ignition transformer.

Engine timing is controlled by the EIS Control Module. It is based on the desired engine timing, customer specified parameters (programmed by the operator) and the conditions in which the engine operates. The engine operator can change the maximum advanced timing, the speed timing maps and load timing maps using the Digital Diagnostic Tool (DDT). The EIS Control Module automatically adjusts the engine timing according to the engine operating conditions, as determined by information from the engine speed/timing sensor, manifold air pressure sensor, and detonation sensors.

The EIS Control Module has up to 16 ignition outputs to the ignition transformers. It also uses sensors and internal circuitry to monitor the system components. If a problem develops in a component or harness, the control will sense the problem and notify the operator by creating a diagnostic code.

Ignition Transformers

Each cylinder has an ignition transformer located under the cylinder valve cover. The EIS Control Module sends a pulse to the primary coil of the ignition transformer to initiate combustion in each cylinder. The transformer steps up the voltage to create an arc across the spa lug gap. The spark created by the arc, ignites the gas in the cylinder. On engines equipped with EIS, the cylinder valve cover acts as the ground for the ignition transformer. Care should be exercised when working on the engine with a valve cover removed. *Always disconnect the primary lead to the transformer when a valve cover is removed.*

The ignition harness connects the EIS Control Module to the individual ignition transformers. The ignition harness is routed inside the engine alongside the camshaft.

Engine Sensors

Engine sensors provide information to the EIS Control Module that allow the module to control the engine as efficiently as possible over a wide range of operating conditions.

Detonation Sensors

The Detonation Sensors (RHDS and LHDS) monitor the engine for excessive detonation (vibration). One sensor is mounted in the center of each cylinder bank. The sensor produces a voltage signal proportional to engine detonation. This information is processed by the EIS Control Module to determine detonation levels and changes engine timing as needed.

Speed/Timing Sensor

The Speed/Timing Sensor provides accurate spark timing information for the control module. A speed/timing ring, mounted on the rear, left camshaft, provides the signal pattern detected by the sensor and read by the control module. The control module determines engine speed and timing position from the sensor signal.

Manifold Air Pressure Sensor (Load Sensor)

The Manifold Air Pressure Sensor provides engine load information to the EIS Control Module. The sensor is connected to the inlet manifold. The information is processed by the control module to determine engine timing and diagnostics.

Desired Timing Parameter

The Desired Timing Parameter allows the customer to electronically program the ignition spark timing of the EIS System to meet specific application/installation needs. The desired timing is programmed using the DDT Service Tool. The desired timing value can be changed while the engine is running or stopped. The value entered for the desired timing is the ignition timing when the engine is operating at rated speed, full load.

Note: Actual ignition timing at a given instance may vary from the desired timing value due to variations in engine speed, detonation activity or type of fuel being used.

Fuel, Air Inlet and Exhaust Systems

Engine Basics

On a four-stroke gas engine during the intake stroke, a change of fuel and air (mixed outside the combustion chamber in the carburetor) is drawn (NA) or forced (TA) through the intake valve (Figure 3). This mixture of fuel and air is compressed on the compression stroke and is then ignited by a spark. This spark is generated and timed by the Electronic Ignition System (EIS). The piston is then forced downward, creating the power stroke, toward bottom dead center by the expanding gases. On the exhaust stroke, the burned gases are pushed out of the cylinder through the exhaust valve as the piston travels back toward top dead center.

Diesel engines, like natural gas engines, operate in a slightly different way, although the four strokes are the same. On the intake stroke, only air is drawn or forced into the compression chamber. On the compression stroke, the air is compressed and therefore heated; just before the piston reaches top dead center, fuel is injected under high pressure. The fuel-air mixture will ignite by itself at the beginning of the power stroke.

Diesel engines are typically limited by their capabilities to carry structural load with peak pressures up to 10 335 kPa (1500 psi). Gas engines are limited by their capability to carry thermal load-high exhaust temperatures.

The gas engine runs with higher exhaust temperatures because it runs with a constant air-fuel ratio at any load. The diesel engine runs with an excess amount of air at any load. Only the amount of fuel burned increases with

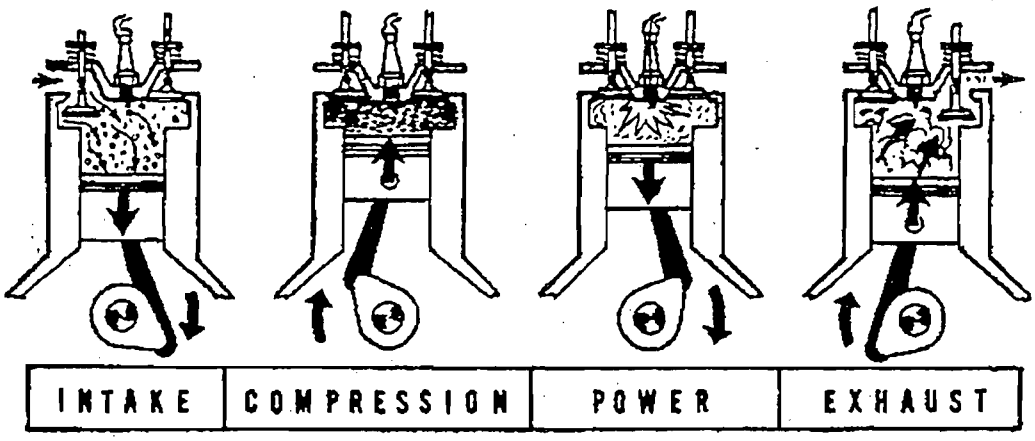


Figure 3. Four-stroke process.

the load. This additional air also cools the charge in diesel engines.

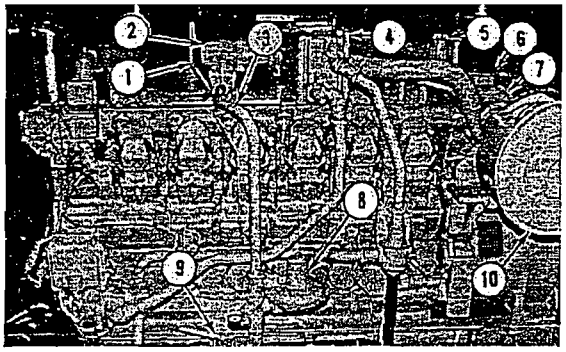


Figure 4. Fuel, Air Inlet And Exhaust System Components (G3512 Engine Shown)
(1) Balance line between carburetor and gas pressure regulator. (2) Carburetor. (3) Gas inlet line to carburetor. (4) Aftercooler. (5) Exhaust bypass valve. (6) Exhaust elbow. (7) Turbocharger. (8) Gas pressure regulator. (9) Gas shutoff valve. (10) Air cleaner.

The components of the fuel, air inlet and exhaust system (Figure 4) control the quality, temperature and amount of air/fuel mixture available for combustion. Some of these components are the gas inlet line (3), air cleaners (10), turbochargers (7), watercooled aftercooler (4), gas shutoff valve (9), gas pressure regulator (8), carburetor (2), turbulence chamber, distribution channel, an inlet manifold and the intake and exhaust valve mechanisms. Two camshafts, one on each side of the block, control the movement of the valve system components.

The inlet manifold is a series of elbows that connect the distribution channel (located in the middle of the engine) to the inlet ports (passages) of the cylinder heads.

There is a separate air cleaner, turbocharger and watercooled exhaust manifold on each side of the engine. The watercooled exhaust manifolds provide a "gas tight" connection from the cylinder heads to the turbochargers. The manifolds also serve as a water manifold by collecting coolant from each cylinder head and directing it to the regulator housing.

All installations have a shutoff valve in the gas supply line. The shutoff valves are either Energized To Run (ETR) or Energized To Shutoff (ETS). All engines with turbochargers have a balance line (1) between the gas shutoff valve and the carburetor.

In the Energized To Run system, power must be supplied to the shutoff valve to keep the fuel coming to the engine. To stop the engine, the power is removed from the shutoff valve, which interrupts the fuel to the engine.

In the Energized To Shutoff system, no power is supplied to the shutoff valve to keep the fuel coming to the engine. To stop the engine, power is supplied to the shutoff valve, which interrupts the fuel to the engine. The valve can also be manually operated to stop the engine. After the engine is stopped, manual resetting of the valve is needed to start the engine.

Fuel System

Several variations of fuel systems for G3500 Engines are available to best suit the individual customer installation. Although each installation may be different, the basic components will be the same or similar. Two different carburetor set-ups (low pressure and high pressure) are available that will determine the components of the rest of the fuel delivery system. The low pressure or high pressure carburetor set-ups may be used with either the Standard (Stoichiometric) or Low Emission engines depending on the inlet pressure of the fuel available to the engine.

Low Pressure Carburetor System

Two different gas pressure regulator arrangements are generally used on engines equipped with low pressure carburetors. Although the position and number of components may differ, both systems function in a similar manner. One arrangement uses a single gas pressure regulator (Figure 5) to supply both carburetors. The regulator will be located at the rear of the engine on a centerline between the turbochargers. The other arrangement uses two gas pressure regulators (Figure 6), one for each carburetor. A regulator will be mounted on both sides of the engine near each carburetor.

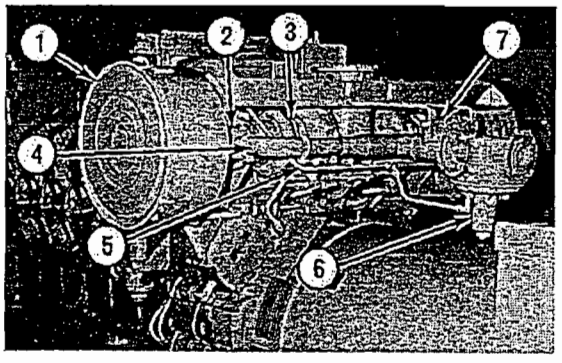


Figure 5. Single Regulator Arrangement
(1) Air cleaner. (2) Low pressure carburetor.
(3) Turbocharger. (4) Gas inlet line. (5) Balance line.
(6) Gas pressure regulator. (7) Gas pressure valve assembly.

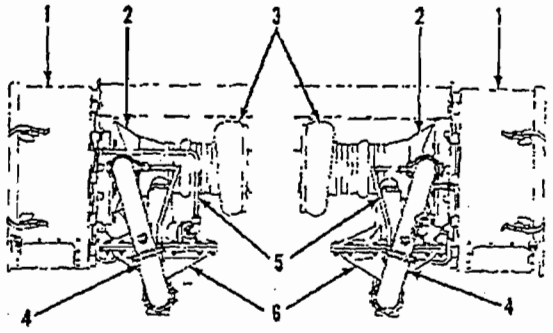


Figure 6 Dual Regulator Arrangement
(1) Air cleaner. (2) Low pressure carburetor.
(3) Turbocharger. (4) Gas inlet line. (5) Balance line.
(6) Gas pressure regulator.

From the main gas supply line, gas enters the gas pressure regulator (6). The gas pressure regulator is adjusted to provide a flow of fuel, at low pressure, to the engine gas inlet line (4). As the compressor wheels of the turbochargers (3) rotate, fuel (at low pressure) is drawn through the fuel inlet lines to the carburetors (2). The carburetors (one on each side of the engine) are located between the air cleaners (1) and the compressor side of the turbochargers. The carburetors mix the fuel with inlet air from the air cleaners. The air/fuel mixture is pulled into the turbochargers, compressed and sent to the aftercooler. The compressed, cooled air/fuel mixture flows from the aftercooler to the throttle group. The throttle group is connected by a linkage to the governor and controls the flow of the air/fuel mixture into the inlet plenum. The air/fuel mixture in the inlet plenum enters the cylinder through the cylinder inlet valves where it is compressed and ignited by the spark plug.

Turbocharged engines have a balance line (5) connected between the carburetor air inlet and the atmospheric vent of gas pressure regulator. The balance line directs carburetor inlet air pressure to the upper side of the regulator diaphragm to control gas pressure at the carburetor. The inlet air pressure added to the spring force on the diaphragm, makes sure that gas pressure to the carburetor will always be greater than inlet air pressure, regardless of load conditions. For example, under engine acceleration, the air pressure

increases. A small amount of the increased air pressure is directed to the gas pressure regulator and moves the control to increase supply gas pressure to the carburetor. By this method, the correct differential pressure between the gas pressure regulator and the carburetor air inlet is controlled. A turbocharged engine will not develop full power with the balance line disconnected.

Engines equipped with a single regulator arrangement, have a gas pressure valve assembly located in the fuel inlet line. The gas pressure valve assembly is used to adjust emission levels at full load, rated speed.

High Pressure Carburetor System

On engines equipped with high pressure carburetors (Figure 7) the gas pressure regulator (4) is usually located on the side of the engine, in line with the carburetor (1) and throttle group.

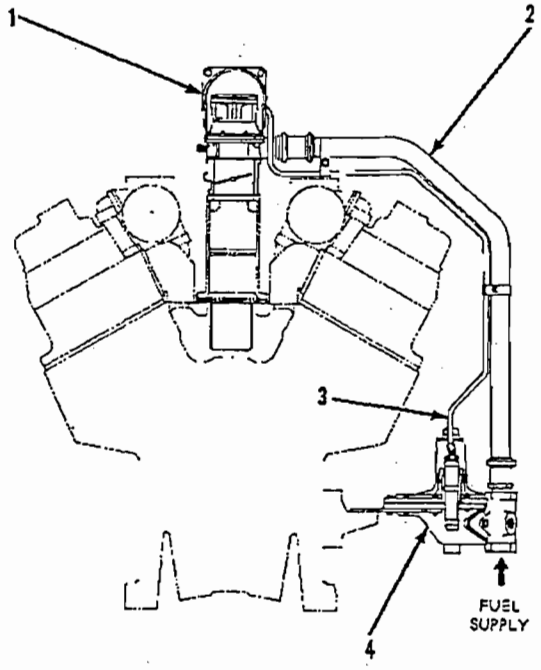


Figure 7. High Pressure Carburetor
(1) Carburetor. (2) Gas supply line to carburetor.
(3) Balance line from gas pressure regulator vent to inlet air pressure at carburetor. (4) Gas pressure regulator.

From the main fuel supply inlet, fuel enters the gas pressure regulator. The pressure regulated fuel flows through the air/fuel ratio control valve. The air/fuel ratio control valve is operated by the actuator and the control valve linkage. Gas goes from the air/fuel ratio control valve through the gas supply line (2) and then into the carburetor. Air is drawn in through the air cleaners and into the turbochargers. The turbochargers compress the air and send it to the aftercooler. The aftercooler lowers the temperature of the compressed air and the air enters the carburetor. The carburetor mixes the fuel and the air. The air/fuel mixture passes through the throttle and into the air inlet plenum. The throttle group is connected by a linkage to an EG-3P Actuator and controls the flow of the air/fuel mixture into the inlet plenum. The air/fuel mixture in the inlet plenum enters the cylinder through the cylinder intake valves where it is compressed and ignited by the spark plug.

Turbocharged engines have a balance line (3) connected between the carburetor air inlet and the atmospheric vent of the gas pressure regulator. The balance line directs carburetor inlet air pressure to the upper side of the regulator diaphragm to control gas pressure at the carburetor. The inlet air pressure added to the spring force on the diaphragm, makes sure that gas pressure to the carburetor will always be greater than inlet air pressure, regardless of load conditions. For example, under engine acceleration, the air pressure increases. A small amount of the increased air pressure is directed to the gas pressure regulator and moves the control to increase supply gas pressure to the carburetor. By this method, the correct differential pressure between the gas pressure regulator and the carburetor air inlet is controlled. A turbocharged engine will not develop full power with the balance line disconnected.

Gas Pressure Regulator

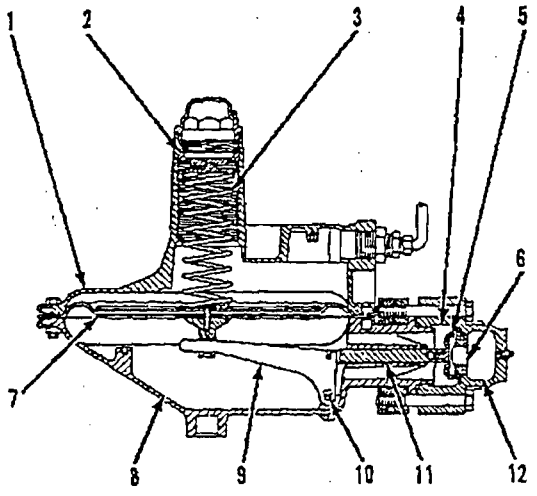


Figure 8 Regulator Operation
(1) Spring side chamber. (2) Adjustment screw. (3) Spring. (4) Outlet. (5) Valve disc. (6) Main orifice. (7) Main diaphragm. (8) Lever side chamber. (9) Lever. (10) Pin. (11) Valve stem. (12) Inlet.

The function of the gas pressure regulator is to maintain a set pressure differential between the outlet of the gas pressure regulator (connected to the carburetor fuel inlet) and the carburetor air inlet. G3500 Engines can be equipped with different regulators to use a variety of fuels and a wide range of gas pressures and BTU ratings. The construction and position on the engine may vary, but all function on similiar principles and work to maintain an adjusted pressure differential. The following is a description of operation for a high pressure, high BTU content fuel regulator.

Gas goes through the inlet (12), main orifice (6), valve disc (5), and the outlet (4). Outlet pressure is felt in the chamber (8) on the lever side of diaphragm (7).

As gas pressure in chamber (8) becomes higher than the force of the diaphram spring (3) and air pressure in the spring side chamber (1) (atmosphere on naturally aspirated engines; turbocharger boost on turbocharged engines), the diaphragm is pushed against the spring. This turns the lever (9) at pin (10) and causes the valve stem (11) to move the valve disc to close the inlet orifice.

With the inlet orifice closed, gas is pulled from the lever side of chamber (8) through the outlet. This gives a reduction of pressure in the chamber (8). As a result the pressure becomes less than pressure in the spring side chamber. Force of spring and air pressure in the chamber on the spring side moves the diaphragm toward the lever. This turns (pivots) the lever and opens the valve disc, permitting additional gas flow to the carburetor.

Carburetor

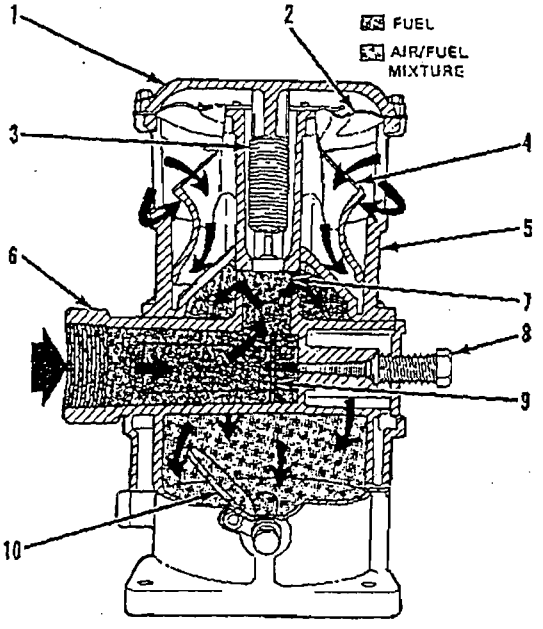


Figure 9. Carburetor Operation
(1) Cover. (2) Diaphragm. (3) Spring. (4) Air valve. (5) Air valve body. (6) Gas inlet body. (7) Gas valve. (8) Power screw. (9) Plate. (10) Throttle plate.

Note: Operation of a carburetor (Figure 9) with a single air valve is described. Operation of carburetors with dual air valves is the same.

Atmospheric air goes through the air cleaners to the air horn of the carburetor on naturally aspirated engines. On turbocharged engines, the air is pulled through the air cleaners to the turbochargers and then pushed through an aftercooler core to the carburetor air horn. In the air horn, air goes around the air valve body (5) and pushes on diaphragm (2) and then goes down through the center of air valve

(4), around gas inlet body (6), by throttle plate (10) into the engine.

Fuel goes into the carburetor at the center, through the gas inlet body. The fuel flows out the top of the gas inlet body to mix with the air and then flows around the gas inlet body, by the throttle plate into the engine. Gas valve (7) is connected to the air valve and is designed to let the correct amount of fuel into the carburetor at any opening of the air valve between idle and full load. Thus, at low idle, the gas valve keeps fuel flow to a minimum and gives a lean air fuel mixture. As the engine speed and load is increased, the gas valve lets more fuel flow to give a richer air fuel mixture. When the engine is stopped, the spring holds the gas valve down against the valve seat in the closed position and no fuel can enter the carburetor. Power screw (8) and plate (9) control fuel inlet at full load conditions when the gas valve is at a maximum distance off its seat.

As the engine is started, the intake strokes of the pistons cause a vacuum in the cylinders which causes a low pressure condition below the carburetor. Passages in air valve body (5) connect the low pressure to the upper side of the diaphragm. At this point, atmospheric pressure pushes up on the diaphragm and lifts it against the downward force of the spring. The air valve is connected to and pulled up by the diaphragm. At this point, air can push upward against the outside of the air valve to help lift it. The gas valve is connected to the air valve and is also lifted off its seat to let fuel enter the carburetor. The air pushes up on the diaphragm and at the same time goes around the outside and inside of the air valve and around the gas inlet body. As the air passes around the gas inlet body, it mixes with the fuel. The air/fuel mixture then goes down by the throttle plate, into the distribution channels, to the inlet manifolds and then into the cylinders for combustion.

2301A Electric Governor

The 2301A Electric Governor Control System consists of the components that follow: 2301A Electric Governor Control (EGC) , Actuator, Magnetic Pickup.

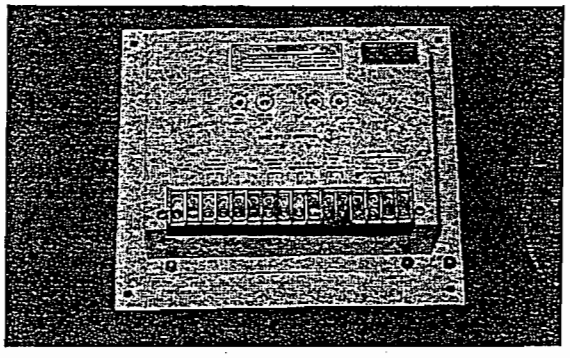


Figure 10. 2301A Electric Governor Control (EGC)

The 2301A Electric Governor System gives precision engine speed control. The 2301A control(Figure 10) measures engine speed constantly and makes necessary corrections to the engine fuel setting through an actuator connected to the fuel system.

The engine speed is felt by a magnetic pickup (Figure 11). This pickup is a single pole, permanent magnet generator made of wire coils (2) around a permanent magnet pole piece. (4). See Figure 12. As the teeth of the flywheel ring gear (5) cut through the magnetic lines of force (1) around the pickup, an AC voltage is generated. The frequency of this voltage is directly proportional to engine speed.

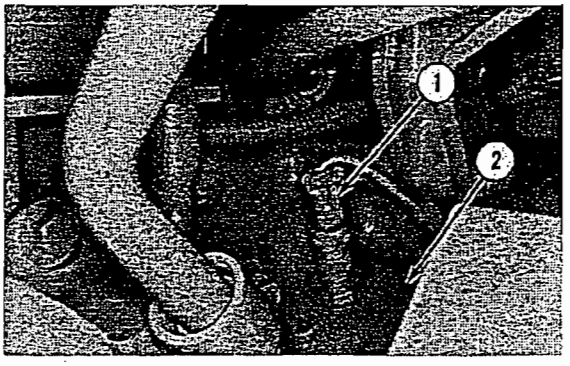


Figure 11. Magnetic Pickup Location
(1) Magnetic pickup. (2) Flywheel housing.

This engine speed frequency signal (AC) is sent to the 2301A Control Box where a conversion is made to DC voltage. The DC signal is now sent on to control the actuator, and this voltage is inversely proportional to engine speed. This means that if engine speed increases, the voltage output to the actuator decreases. When engine speed decreases, the voltage output to the actuator increases.

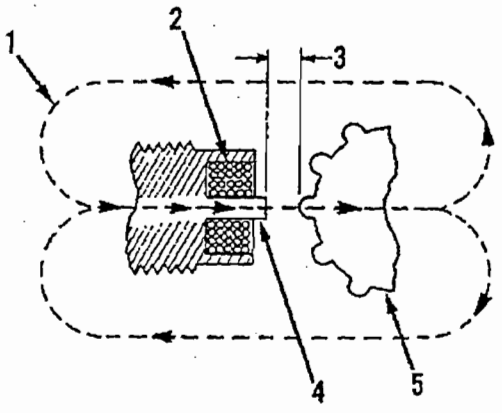


Figure 12. Schematic Of Magnetic Pickup
(1) Magnetic lines of force. (2) Wire coils. (3) Gap. (4) Pole piece. (5) Flywheel ring gear.

The actuator ((Figure 13) changes the electrical input from the 2301A Control to a mechanical output that is connected to the fuel system by linkage. For example, if the engine speed is more than the speed setting, the 2301A Control will decrease its output and the actuator will now move the linkage to decrease the fuel to the engine.

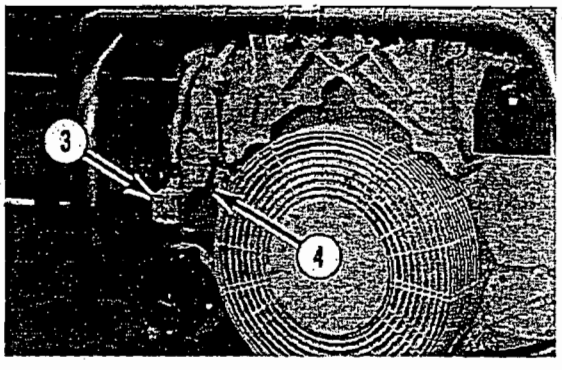


Figure 13. EG3P Actuator.
(3) Actuator. (4) Actuator lever.

Woodward PSG Governors

The Woodward PSG (Pressure compensated Simple Governor) can operate as an isochronous or a speed droop type governor. It uses engine lubrication oil, increased to a pressure of 1200 kPa (175 psi) by a gear type pump inside the governor, to give hydra/mechanical speed control.

The governor (Figure 15) is driven by the governor drive unit. This unit turns pilot valve bushing (13) clockwise as seen from the drive unit end of the governor (Figure 14). The pilot valve bushing is connected to a spring driven ballhead. Flyweights (7) are fastened to the ballhead by pivot pins. The centrifugal force caused by the rotation of the pilot valve bushing causes the flyweights to pivot out. This action of the flyweights changes the centrifugal force to axial force against speeder spring (5). There is a thrust bearing (9) between the toes of the flyweights and the seat for the speeder spring. Pilot valve (12) is fastened to the seat for the speeder spring. Movement of the pilot valve is controlled by the action of the flyweights against the force of the speeder spring.

The engine is at the governed (desired) rpm when the axial force of the flyweights is the same as the force of compression in the speeder spring. The flyweights will be in the position shown. Control ports (14) will be closed by the pilot valve.

When the force of compression in the speeder spring increases (operator increases desired rpm) or the axial force of the flyweights decreases (load on the engine increases) the pilot valve will move in the direction of the drive unit. This opens the control ports(14). Pressure oil flows through a passage in the base to chamber (B). The increased pressure in the chamber causes power piston (6) to move. The power piston pushes strut assembly (4), that is connected to output shaft lever (3). The action of the output shaft lever causes counterclockwise rotation of output shaft (2). This moves carburetor control linkage (15) in the THROTTLE OPENED direction (Figure 15).

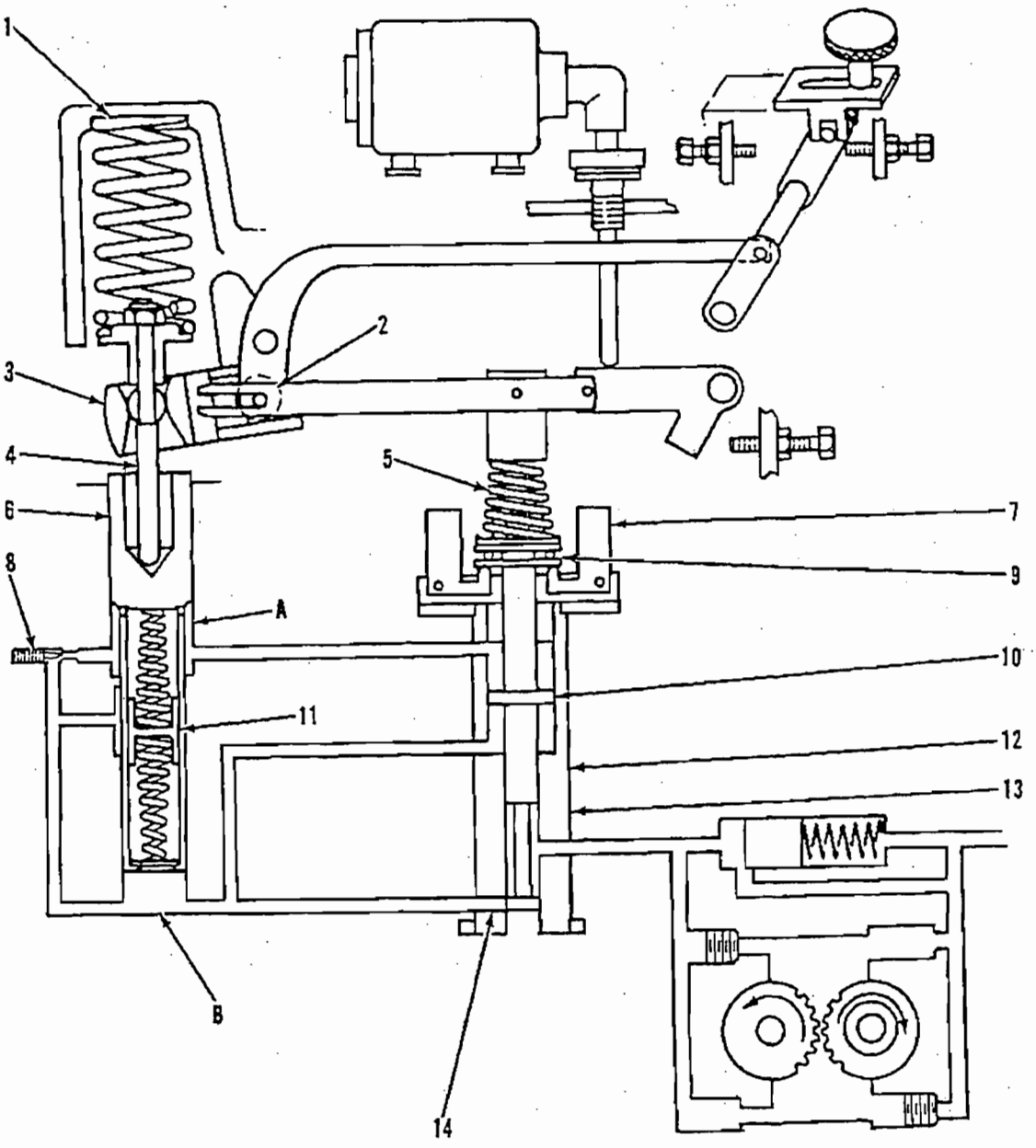


Figure 14. Schematic Of PSG Governor
(1) Return spring. (2) Output shaft. (3) Output shaft lever. (4) Strut assembly. (5) Speeder spring. (6) Power piston. (7) Flyweights. (8) Needle valve. (9) Thrust bearing. (10) Pilot valve compensating land. (11) Buffer piston. (12) Pilot valve. (13) Pilot valve bushing. (14) Control ports. (A) Chamber. (B) Chamber.

Figure 15. PSG Governor Installed
(2) Output shaft. (15) Carburetor control linkage.

As the power piston moves in the direction of return spring (1) the volume of chamber (A) increases. The pressure in the chamber decreases. This pulls the oil from the chamber inside the power piston, above buffer piston (11) into the chamber (A). As the oil moves out from above the buffer piston to fill the chamber the buffer piston moves up in the bore of the power piston. Chambers (A and B) are connected respectively to the chambers above and below the pilot valve compensating land (10). The pressure difference felt by the pilot valve compensating land adds to the axial force of the flyweights to move the pilot valve up and close the control ports. When the flow of pressure oil to chamber (B) stops so does the movement of the fuel control linkage.

When the force of compression in the speeder spring decreases (operator decreases desired rpm) or the axial force of the flyweights increases (load on the engine decreases) the pilot valve will move in the direction of the speeder spring. This opens the control ports. Oil from chamber (B) and pressure oil from the pump will dump through the end of the pilot valve bushing. The decreased pressure in chamber (B) will let the power piston move in the direction of the drive unit. The return spring pushes against the strut assembly. This moves the output shaft lever. The action of the output shaft lever causes clockwise rotation of the output shaft. This moves the carburetor control linkage in the THROTTLE CLOSED direction, (Figure 15).

On PSG governors not equipped with electric speed adjustment (Figure 16), speed can be adjusted with screw (1). When the screw is turned clockwise it pushes the link assembly (2) against speeder spring (3). This causes an increase in the force of speeder spring and pilot valve (4) will move toward governor drive unit. The engine will increase speed until it gets to the desired rpm. When the screw is turned counterclockwise the link assembly moves away from speeder spring. This causes a decrease in the force of the speeder spring and the pilot valve will move away from governor drive unit. The engine will decrease speed until it gets to the desired rpm.

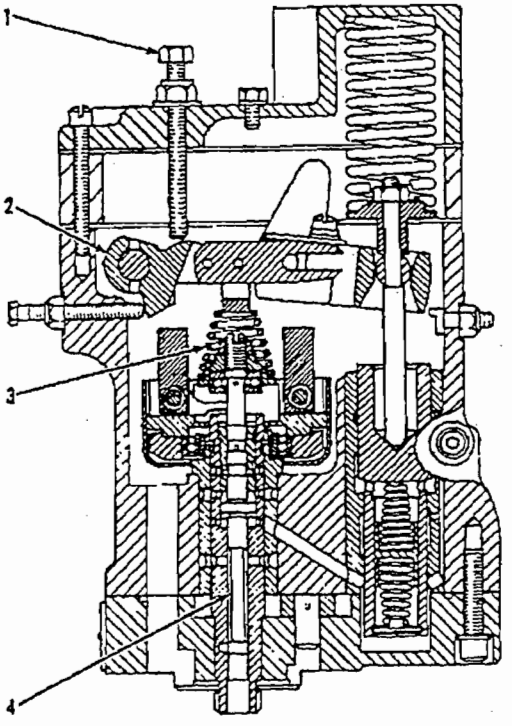


Figure 16. Non-electric PSG Governor
(1) Screw. (2) Link assembly. (3) Speeder spring.
(4) Pilot valve.

Engines with non-electric governors are also equipped with a governor control group (Figure 17) to allow easier speed adjustment.

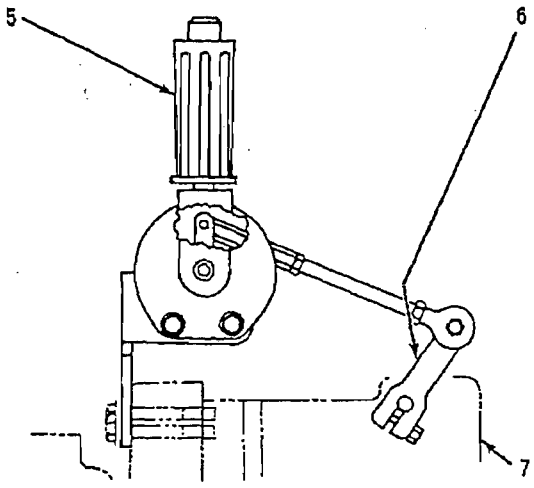


Figure 17. Governor Control Group
(5) Positive lock lever. (6) Link assembly lever.
(7) Governor.

As lever (5) is moved toward governor (7), linkage causes lever (6) to move in the same direction. The link assembly lever is clamped to the shaft of the link assambly (2). As the shaft rotates, the link assembly pushes against speeder spring (3). This causes pilot valve (4) to move toward the governor drive unit. The engine will increase speed until it gets to desired rpm.

When lever (5) is moved away from the governor, the link assembly lever moves in the same direction. This causes the link assembly to move away from the speeder spring. The pilot valve then moves away from the governor drive unit and engine speed decreases until desired rpm is reached.

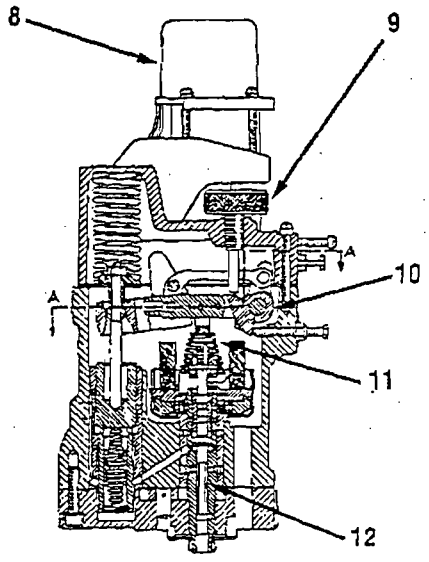


Figure 18 PSG Electric-Type Governor
(8) Synchronizing motor. (9) Clutch assembly.
(10) Link assembly. (11) Speeder spring. (12) Pilot valve.

On electric type PSG governors (Figure 18), speed adjustments are made by a 24V DC reversible synchronizing motor (8). The motor is controlled by a switch that can be put in a remote location.

The synchronizing motor drives clutch assembly (9). The clutch assembly protects the motor if it is run against the adjustment stops.

When the clutch assembly is turned clockwise it pushes link assembly (10) against speeder spring (11). The force of compression in the speeder spring is increased. This causes the pilot valve (12) to move toward the governor drive unit. The engine will increase speed, then get stability at a new desired rpm.

When the clutch assembly is turned counterclockwise the link assembly moves away from the speeder spring. The force of compression in the speeder spring is decreased. This causes the pilot valve to move away from the governor drive unit. The engine will decrease speed, then get stability at a new desired rpm.

Note: The clutch assembly can be turned manually if necessary.

Speed droop is the difference between no load rpm and full load rpm. This difference in rpm divided by the full load rpm and multiplied by 100 is the percent of speed droop.

$$\frac{\text{No load speed} - \text{Full load speed}}{\text{Full load speed}} \times 100$$

$$= \% \text{ of speed droop}$$

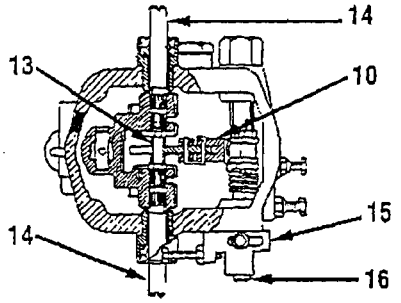


Figure 19. PSG Governor (View A-A from Figure 18) (10) Link assembly. (13) Pivot pin. (14) Output shafts. (15) Droop adjusting bracket. (16) Shaft assembly.

The speed droop of the PSG governor can be adjusted. The governor is isochronous when it is adjusted so that the no load and full load rpm is the same. Speed droop permits load division between two or more engines that drive generators connected in parallel or generators connected to a single shaft.

Speed droop adjustment on PSG governors (Figure 19) is made by movement of pivot pin (13). When the pivot pin is put in alignment with output shafts (14), movement of the output shaft lever will not change the force of the speeder spring. When the force of the speeder spring is kept constant, the desired rpm will be kept constant. When the pivot pin is moved out of alignment with the output shafts, movement of the output shaft lever will change the force of the speeder spring proportional to the load on the engine. When the force of the speeder spring is changed, the desired rpm of the engine will change.

An adjustment bracket (15) outside the governor connected to the pivot pin by the link assembly and shaft assembly (16) is used to adjust speed droop.

Air Inlet And Exhaust Systems

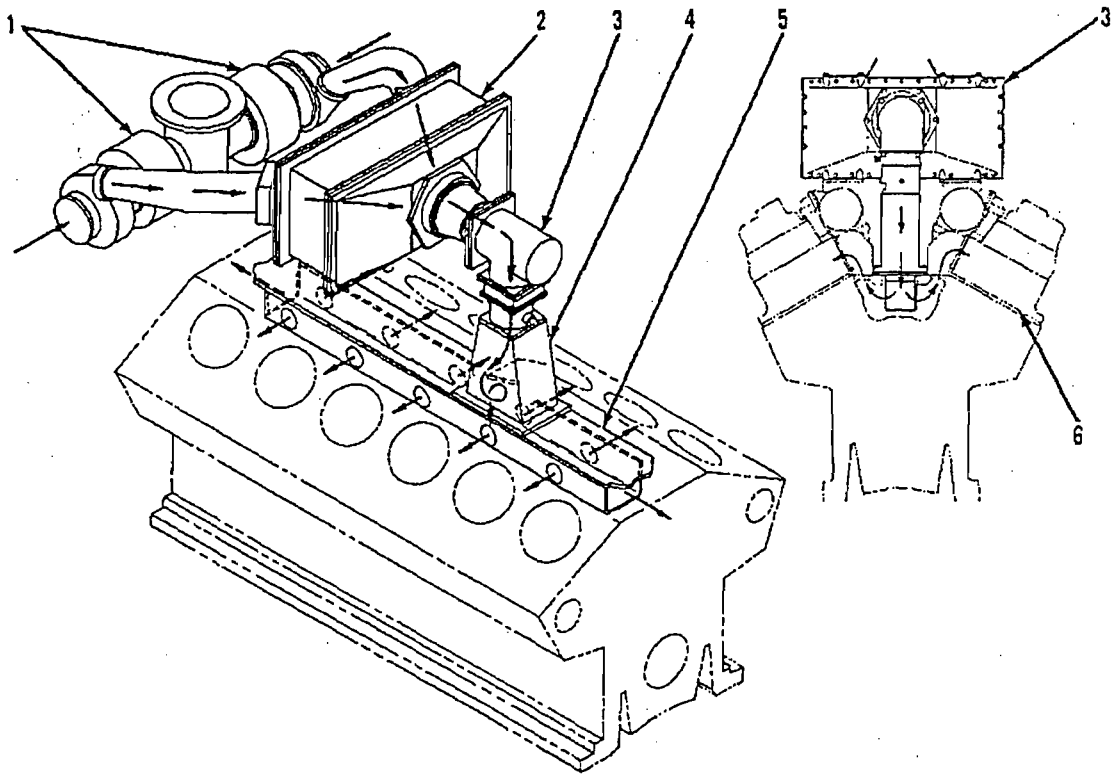


Figure 20. Air Inlet System
(1) Turbochargers. (2) Aftercooler. (3) Carburetor. (4) Turbulence chamber. (5) Distribution channel. (6) Cylinder head.

Air flow is the same on both sides of the engine. See Figure 21. Clean inlet air from the air cleaners is pulled through the turbocharger compressor housing (1) by a compressor wheel (Figure 20). Rotation of the compressor wheel causes compression of the air and forces it through lines to the aftercooler (2). The aftercooler lowers the compressed air temperature and provides air at a constant temperature to the carburetor (3) for maximum air/fuel ratio control, independent of load on the engine. The aftercooler is usually watercooled, but air-to-air aftercooling can be used.

From the aftercooler the air goes through the carburetor (where it mixes with gas) and then into a turbulence chamber (4) which keeps the air and fuel mixed. A distribution channel (5) is located below the turbulence chamber and has holes in it to direct an equal air/fuel mixture at a constant temperature to each cylinder head (6) inlet port. Air flow from the inlet ports into the cylinder combustion chamber is controlled by the intake valves.

There are two intake and two exhaust valves for each cylinder. Make reference to *Valve System Components*. The intake valves open when the piston moves down on the intake stroke. The cooled, compressed air/fuel mixture from the inlet port is pulled into the cylinder. The intake valves close and the piston starts to move up on the compression stroke. When the piston is near the top of the compression stroke, the Electronic Ignition System control module sends voltage through a transformer to the spark plug. The transformer increases the voltage until a spark is created across the plug gap. The spark ignites the air/fuel mixture and combustion starts. The force of combustion pushes the piston down on the power stroke. When the piston moves up again it is on the exhaust

stroke. The exhaust valves open and the exhaust gases are pushed through the exhaust port into the exhaust manifolds (8). See Figure 21. After the piston completes the exhaust stroke, the exhaust valves close and the cycle (intake, compression, power, exhaust) starts again.

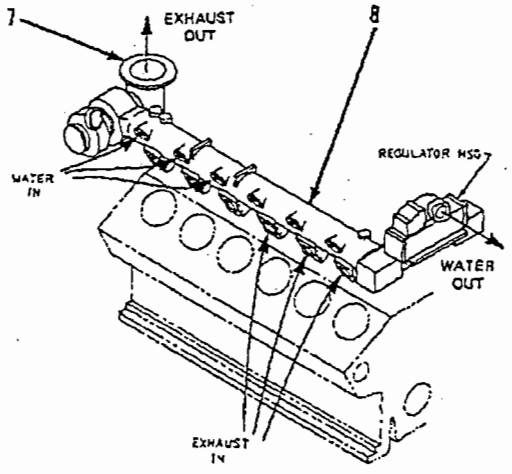


Figure 21. Exhaust System
(7) Exhaust elbow. (8) Exhaust manifold.

Exhaust gases from the exhaust manifolds go into the turbine side of each turbocharger and cause a turbine wheel to turn. The turbine wheel is connected to the shaft that drives the compressor wheel. The exhaust gases then go out the exhaust outlet through the exhaust elbow (7). Changes in engine load and fuel burned cause changes in rpm of the turbine and compressor wheels. As the turbocharger air pressure boost increases, the ratio of air to fuel can change. To increase air and gas densities equally during increased boost, a balance line is connected between the carburetor air inlet and the atmospheric vent of the gas pressure regulator.

Aftercooler

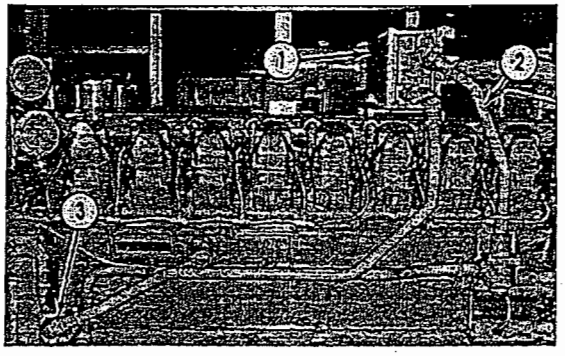


Figure 22. Engine With Watercooled Aftercooler
(1) Aftercooler. (2) Coolant return line. (3) Water pump.

The aftercooler (Figure 23) is located in the air lines between the turbochargers and the carburetor. The aftercooler is usually watercooled (Figure 22) but can be an air to air type.

Watercooled aftercoolers (1) have a separate circuit cooling system, from the engine jacket water cooling system. Coolant is supplied to the water pump (3). The water pump sends coolant through the coolant inlet line into the bottom of the aftercooler. It then flows through the core assembly and back out of the aftercooler through coolant return line (2) to the thermostatic valve that is installed in the coolant return line, to keep coolant in the aftercooler core assembly at the correct temperature.

Air flow through both cooling systems is as follows. Inlet air from the compressor side of the turbochargers flows into the aftercooler through pipes. This air then passes through the aftercooler core assembly which lowers the temperature. The cooler air (mixed with fuel on low pressure carburetor engines) goes out of the aftercooler into the carburetor. Fuel is mixed with the inlet air (on engines equipped with high pressure carburetors). The air/fuel mixture goes through the turbulence chamber and distribution channel and up through the elbows to the intake ports (passages) in the cylinder heads. The mixture goes through the intake valves into the combustion chambers.

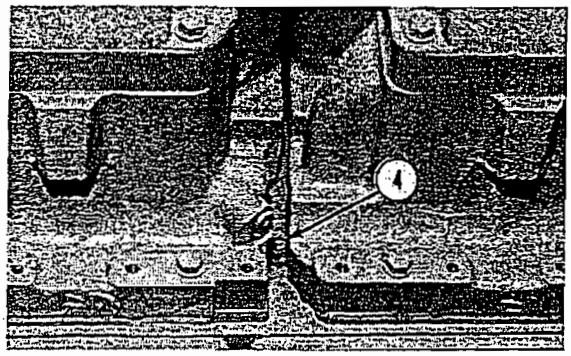


Figure 23. Distribution Channel And Air Chamber Drain
(4) Drain plug.

All engines have two drain plugs (4) installed (Figure 23). One drain plug is located between the No. 1 and No. 3 cylinder heads, and another plug is located between the last two cylinder heads on the left side of the engine. These plugs can be removed to check for water or coolant in the cylinder block air chamber.

Air to air aftercooled systems (Figures 24–26) contain a temperature controller that is pressurized to keep dirt and moisture out of it and a bypass valve which consists of an actuator and valve positioner (5). The temperature controller (12) monitors inlet air temperature and is adjusted to keep it at 43°C (110°F). If the air temperature is too cold, the temperature controller signals an actuator (with pneumatic or gas pressure) to bypass the aftercooler core so air flows from the turbochargers (8) directly into the carburetor (7).

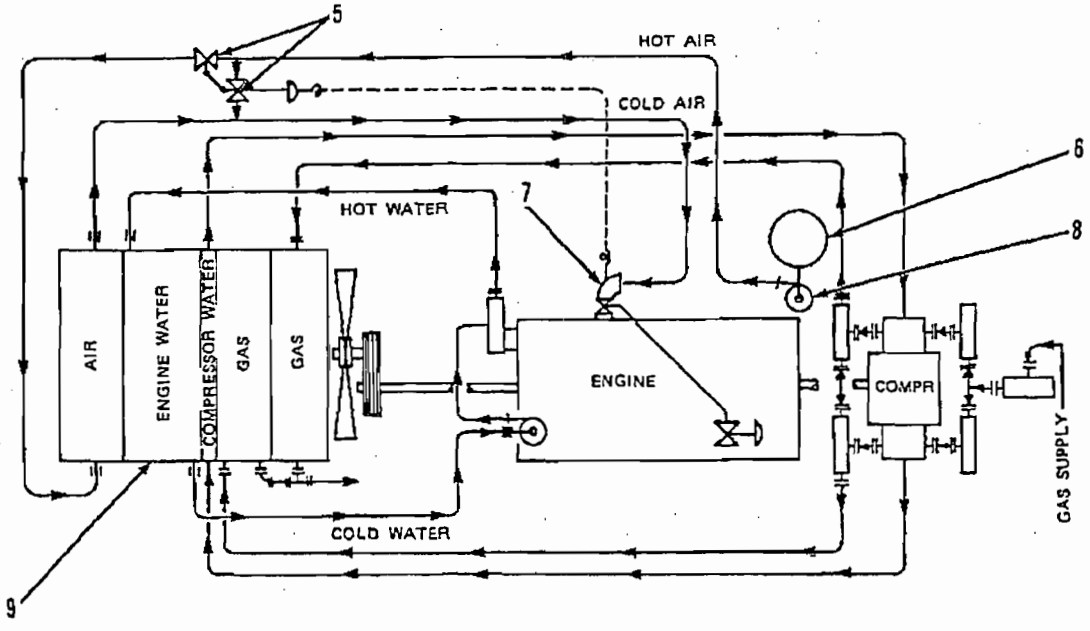


Figure 24. Schematic Of An Air To Air Aftercooler Engine
(5) Actuator with valve positioner. (6) Air cleaner. (7) Carburetor. (8) Turbocharger. (9) Cooling unit.

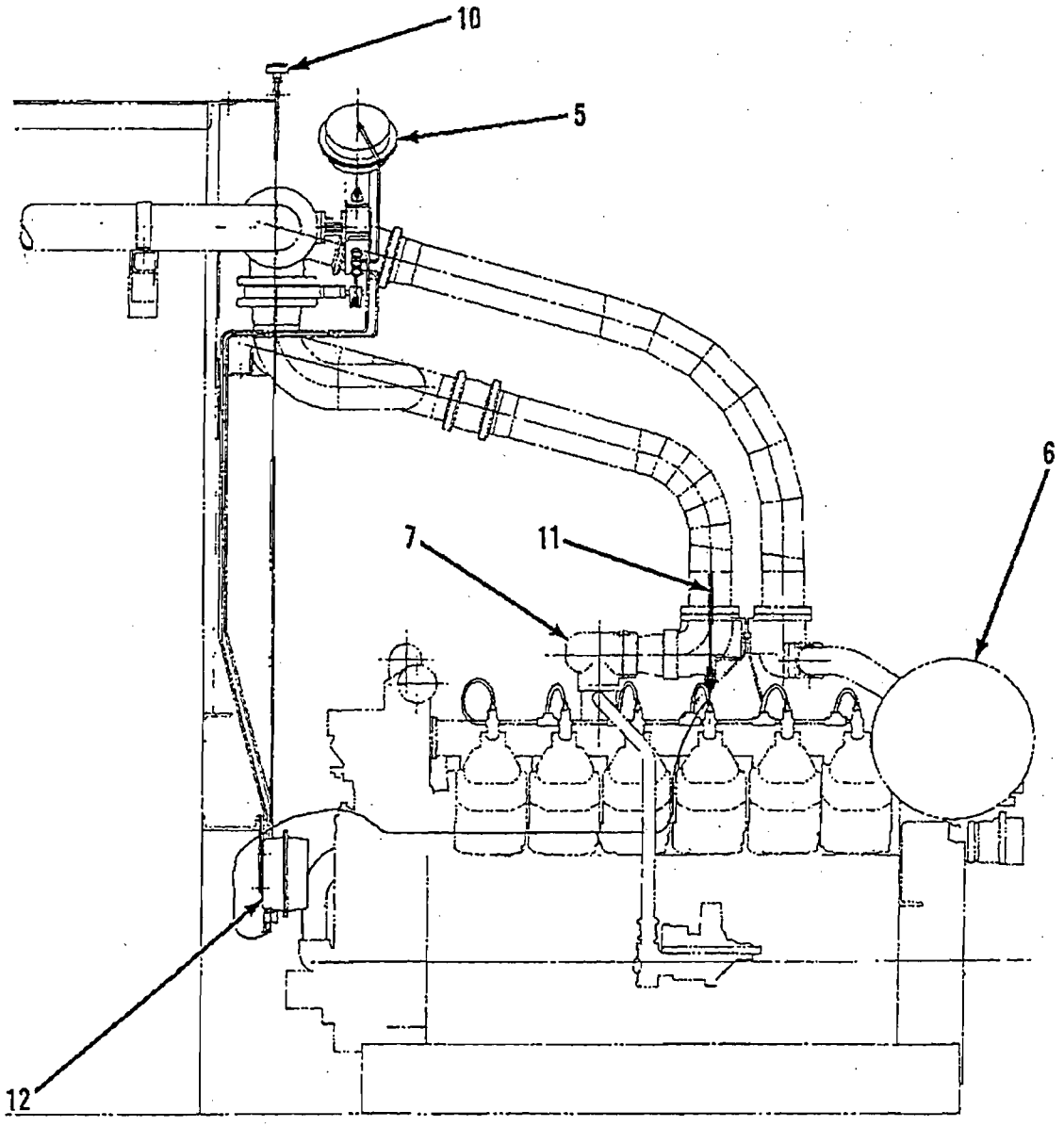


Figure 25. Typical Air To Air Aftercooled System
(5) Actuator with valve positioner. (6) Air cleaner. (7) Carburetor. (10) Vent cap for temperature controller. (11) Sensing element for temperature controller. (12) Temperature controller.

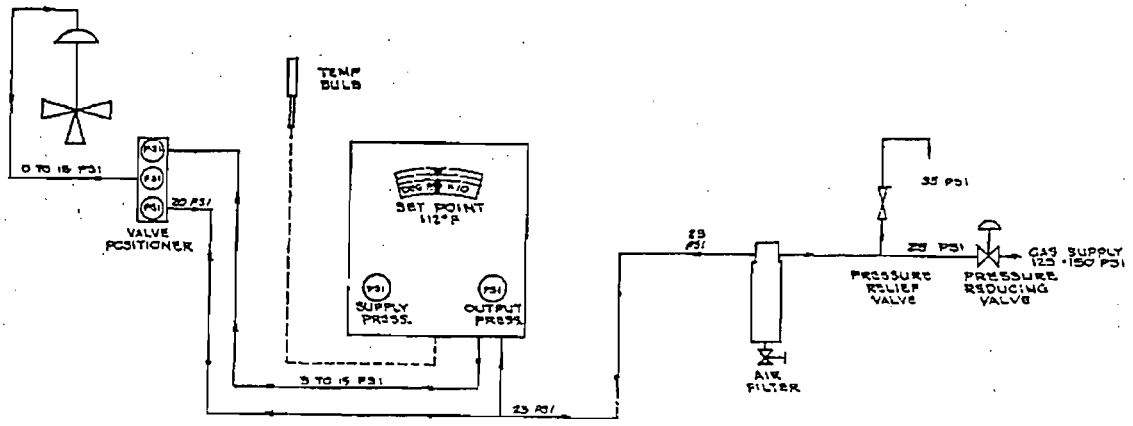


Figure 26. Schematic Of Instrument Installation For Air To Air Aftercooled Systems

Turbochargers

On turbocharged engines there are two turbochargers (Figures 27 and 28), on the rear of the engine. Each turbocharger has a turbine wheel (exhaust side) and a compressor wheel (inlet side). The two wheels are mounted on a common shaft and turn together. The turbine side of the turbochargers is fastened to the exhaust manifolds. The compressor side of the turbocharger is connected to the aftercooler.

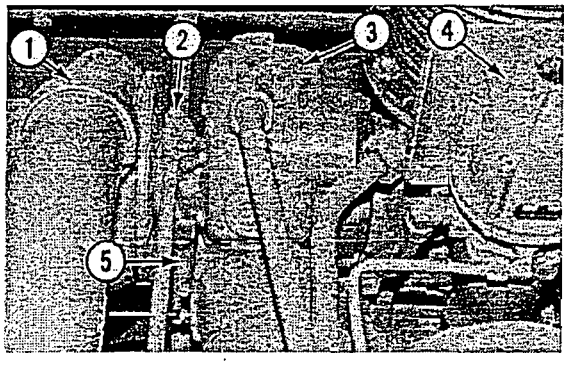


Figure 27. Turbochargers
(1) Turbocharger inlet. (2) Oil inlet line.
(3) Water cooled turbine housing. (4) Exhaust bypass valve. (5) Oil drain line.

Exhaust gases are regulated by the exhaust bypass valve (4). The exhaust gas enters the turbine housing (3) and pushes against the blades of the turbine wheel (10). The turbine wheel is connected to the same shaft as the compressor wheel. Rotation of the turbine wheel causes the compressor wheel to turn.

At high idle, the shaft can rotate at speeds up to 70,000 rpm.

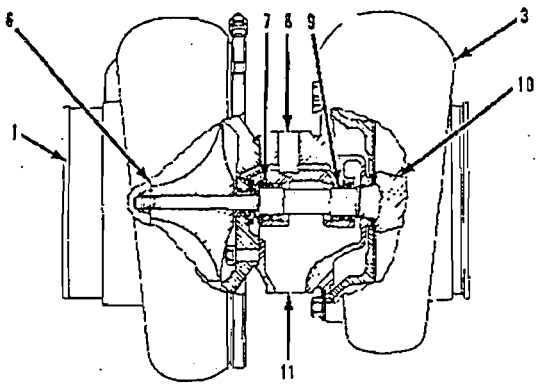


Figure 28. Turbocharger
(6) Compressor wheel. (7) Bearing. (8) Oil inlet.
(9) Bearing. (3) Turbine housing. (10) Turbine wheel.
(1) Air inlet. (11) Oil outlet.

Clean air from the air cleaners is pulled through the compressor housing air inlet (1) by rotation of compressor wheel (6). The action of the compressor wheel blades causes a compression of the inlet air. This compression gives the engine more power because it makes it possible for the engine to burn additional fuel with greater efficiency.

Maximum rpm of the turbocharger is controlled by the fuel setting, the high idle rpm setting and the height above sea level at which the engine is operated.

NOTICE

If the high idle rpm or the fuel setting is higher than given in the Fuel Setting Information Fiche (for the height above sea level at which the engine is operated), there can be damage to engine or turbocharger parts. Damage will result when increased heat and/or friction due to the higher engine output goes beyond the engine cooling and lubrication systems abilities. A mechanic that has the correct training is the only one to make the adjustment of fuel setting and high idle rpm setting.

The bearings (7 and 9) in the turbocharger use engine oil under pressure for lubrication. The oil comes in through oil inlet port (8) and goes through passages in the center section for lubrication of the bearings. Then the oil goes out oil outlet port (11) and back to the oil pan.

Exhaust Bypass Valve (Engines With Turbochargers)

G3500 Engines equipped with turbochargers are also equipped with an adjustable exhaust bypass valve (Figures 29 and 30). The bypass valve can be adjusted for altitude conditions or to adjust the throttle angle for a given load. A high throttle angle at maximum load will reduce resistance to flow by the throttle plate and minimize fuel consumption.

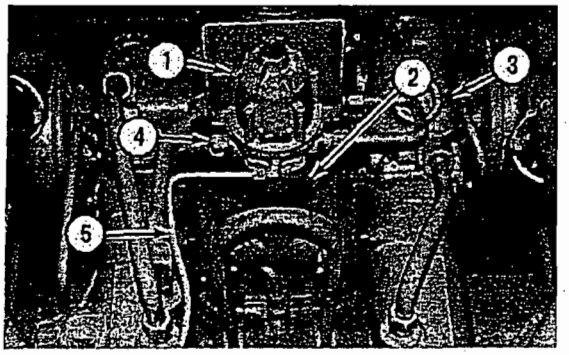


Figure 29. Exhaust Bypass Valve Location
(1) Exhaust bypass valve (2) Exhaust elbow.
(3) Turbocharger turbine housing. (4) Water cooled valve guide housing. (5) Control line from aftercooler to exhaust bypass valve.

The control line from the aftercooler to the exhaust bypass valve (5) connects the compressor side of the turbocharger (through the aftercooler) with the exhaust bypass valve. The exhaust bypass valve (1) is connected through the waste gate housing to the exhaust elbow (2). The bypass valve controls the amount of exhaust gases that enter the turbocharger turbine housing (3) and drive the turbine wheel, or bypass the turbine and go out the exhaust elbow. The guide housing (4) for the bypass valve is water cooled.

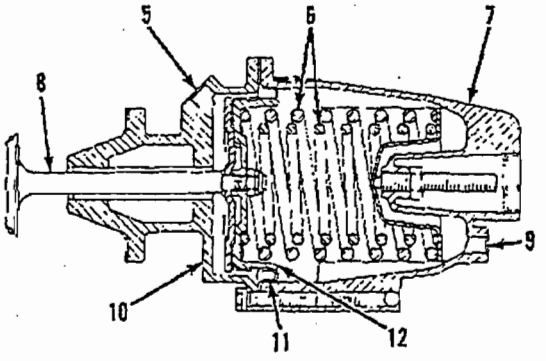


Figure 30. Exhaust Bypass Valve Operation
(5) Control line connection. (6) Springs.
(7) Cover assembly. (8) Poppet valve. (9) Breather location. (10) Guide (base) assembly. (11) Diaphragm. (12) Diaphragm retainer.

Poppet Valve (8) is activated directly by a pressure differential between the air pressure (atmosphere) and the turbocharger compressor outlet pressure to the aftercooler.

One side of the diaphragm (11) in the regulator feels atmospheric pressure through a breather (9) in the top of the regulator. The other side of the diaphragm feels air pressure from the outlet side of the turbocharger compressor through the control line connected to the aftercooler. When outlet pressure to the aftercooler gets to the correct value, the force of the air pressure moves the diaphragm and overcomes the force of the springs (6) and atmospheric pressure. This opens the poppet valve, and allows a portion of the exhaust gases to bypass the turbine wheel. The guide (10) for the poppet valve is water cooled.

Under constant load conditions, the valve will take a set position, permitting just enough exhaust gas to go to the turbine wheel to give the correct air pressure to the aftercooler.

The Exhaust Bypass Valve is preset at the factory. Adjustments may be necessary due to altitude or changes in ambient temperature conditions.

Valve System Components

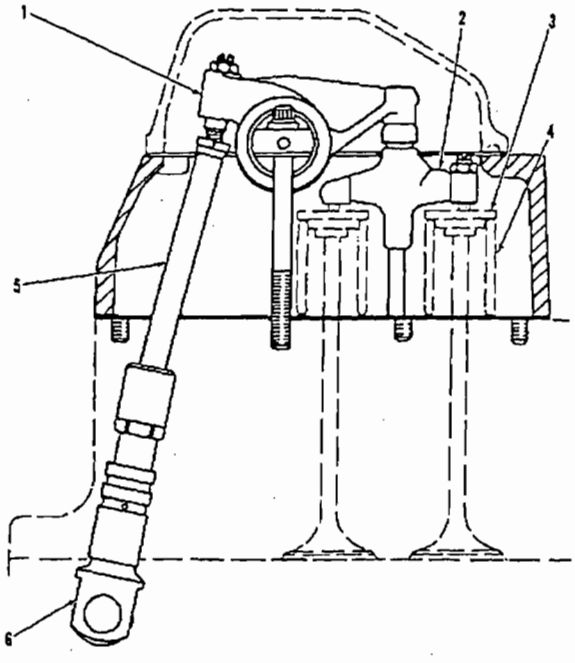


Figure 31. Valve System Components
(1) Rocker arm. (2) Bridge. (3) Rotocoil.
(4) Valve spring. (5) Push rod. (6) Lifter.

The valve system components (Figure 31) control the flow of inlet air and exhaust gases into and out of the cylinders during engine operation.

The crankshaft gear drives the camshaft gears through idlers. Both camshafts must be timed to the crankshaft to get the correct relation between piston and valve movement.

The camshafts have two cam lobes for each cylinder. The lobes operate the valves.

As each camshaft turns, the lobes on the camshafts cause lifters (6) to move up and down. This movement makes push rods (5) move rocker arms (1). Movement of the rocker arms makes bridges (2) move up and down on dowels in the cylinder head. The bridges let one rocker arm open and close two valves (intake or exhaust). There are two intake and two exhaust valves for each cylinder.

Rotocoils (3) cause the valves to turn while the engine is running. The rotation of the valves keeps the deposit of carbon on the valves to a minimum and gives the valves longer service life.

Valve springs (4) cause the valves to close when the lifters move down.

Lubrication System

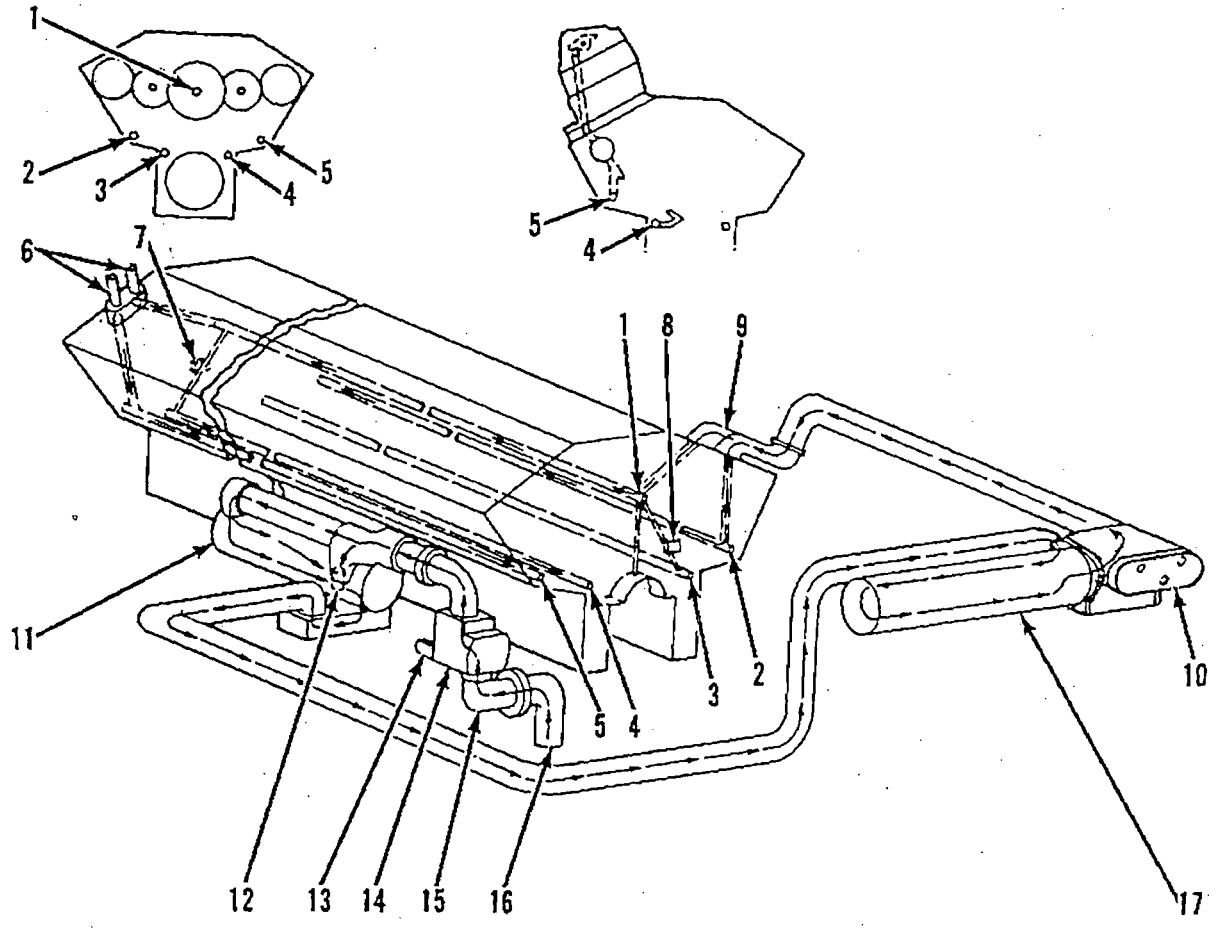


Figure 32. Lubrication System Schematic
(1) Main oil gallery. (2) Left camshaft oil gallery. (3) Piston cooling jet oil gallery. (4) Piston cooling jet oil gallery. (5) Right camshaft oil gallery. (6) Turbocharger oil supply. (7) Sequence valve. (8) Sequence valve. (9) Adapter. (10) Oil filter bypass valve. (11) Oil cooler. (12) Bypass valve. (13) Oil pump relief valve. (14) Engine oil pump. (15) Elbow. (16) Suction bell. (17) Oil filter housing.

This system (Figures 32–36) uses an oil pump (14) with three pump gears that are driven by the front gear train. Oil is pulled from the pan through suction bell (16) and elbow (15) by the oil pump. The suction bell has a screen to clean the oil.

The oil pump pushes oil through oil cooler (11) and the oil filters to oil galleries (1 and 2) in the block. The fin and tube type oil cooler lowers the temperature of the oil before the oil is sent on to the filters.

Bypass valve (12) allows oil flow directly to the filters if the oil cooler becomes plugged or if the oil becomes thick enough (cold start) to increase the oil pressure differential (cooler inlet to outlet) by an amount of 180 ± 20 kPa (26 ± 3 psi).

Note: In certain cogeneration models, with high water temperatures, an oil temperature regulator (instead of the oil cooler bypass valve) is used in the line going to the oil filter. When the oil is thick (cold start) the oil temperature regulator lets oil flow directly to the filters. When the oil temperature regulator opens (engine warm) the oil is sent through the oil cooler to the oil filters.

Cartridge type filters are located in oil filter housing (17) at the front of the engine. A single bypass valve is located in the oil filter housing.

Clean oil from the filters goes into the block through adapter (9). Part of the oil goes to the

left camshaft oil gallery (2) and part goes to the main oil gallery (1).

The camshaft oil galleries are connected to each camshaft bearing by a drilled hole. The oil goes around each camshaft journal, through the cylinder head and rocker arm housing, to the rocker arm shaft. A drilled hole connects the bores for the valve lifters to the oil hole for the rocker arm shaft. The valve lifters get lubrication each time they go to the top of their stroke.

The main oil gallery is connected to the main bearings by drilled holes. Drilled holes in the crankshaft connect the main bearing oil supply to the rod bearings. Oil from the rear of the main oil gallery goes to the rear of right camshaft gallery (5).

Sequence valves (7 and 8) let oil from main oil gallery go to piston cooling jet oil galleries (3 and 4). The sequence valves open at 140 kPa (20 psi). The sequence valves will not let oil into the piston cooling jet oil galleries until there is pressure in the main oil gallery. This decreases the amount of time necessary for pressure build-up when the engine is started. It also helps hold pressure at idle speed.

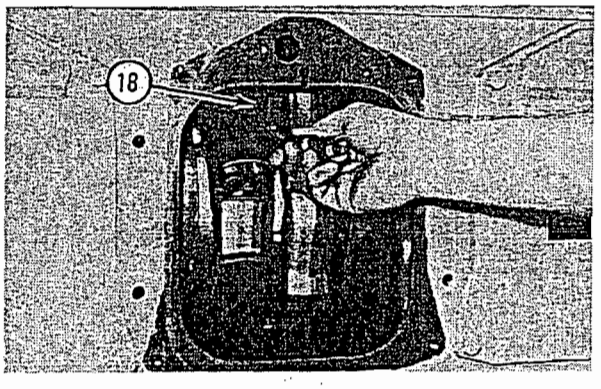


Figure 33. Piston Cooling And Lubrication
(18) Cooling jet.

There is a piston cooling jet (18) below each piston. See Figure 33. Each cooling jet has two openings directed at the center of the piston. This helps cool the piston and gives lubrication to the piston pin.

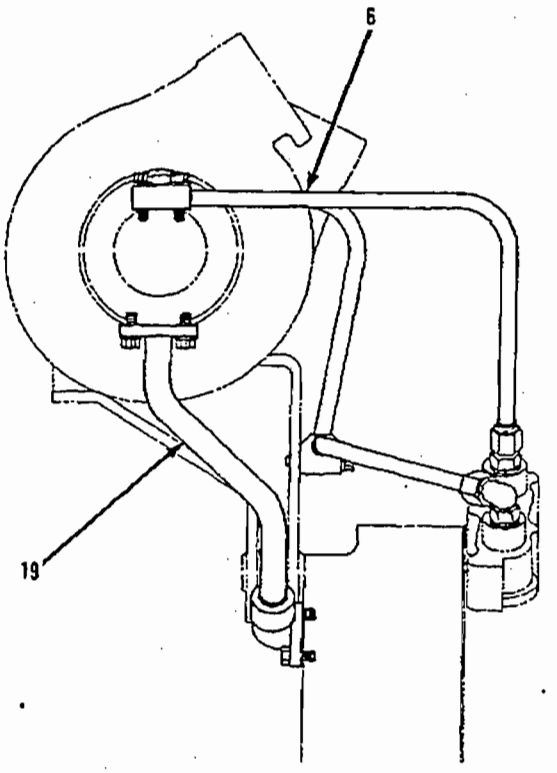


Figure 34. Turbocharger
(6) Oil supply line. (19) Oil drain lines for turbocharger.

Oil lines (6) supply oil to the turbochargers (Figure 34). The turbocharger drain lines (19) are connected to the flywheel housing on each side of the engine.

Oil is sent to the front and rear gear groups through drilled passages in the front and rear housings and cylinder block faces. These passages are connected to camshaft oil galleries (2 and 5).

After the oil for lubrication has done its work, it goes back to the engine oil pan.

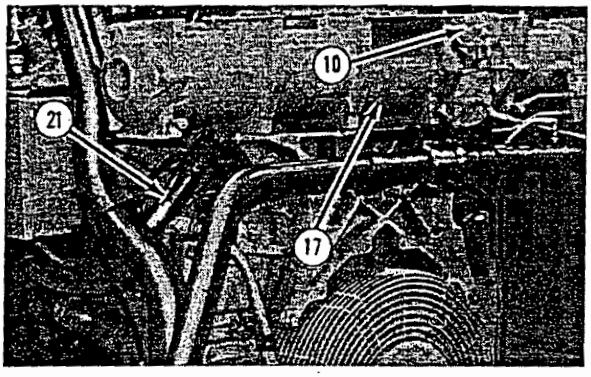


Figure 35. Right Front Side Of Engine
(10) Oil filter bypass valve. (17) Oil filter housing.
(21) Oil line to filter housing.

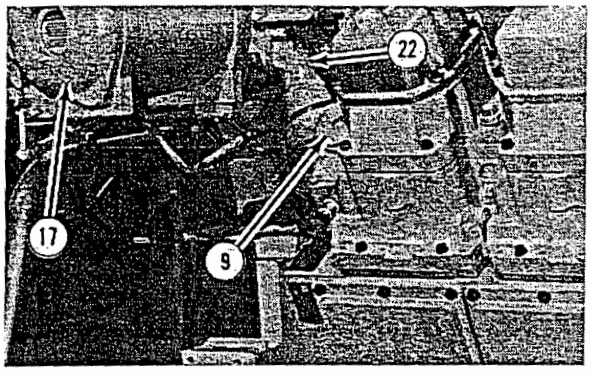


Figure 36. Left Front Of Engine
(9) Adapter. (17) Oil filter housing. (22) Oil outlet line from oil filter housing.

Cooling System

Jacket Water System

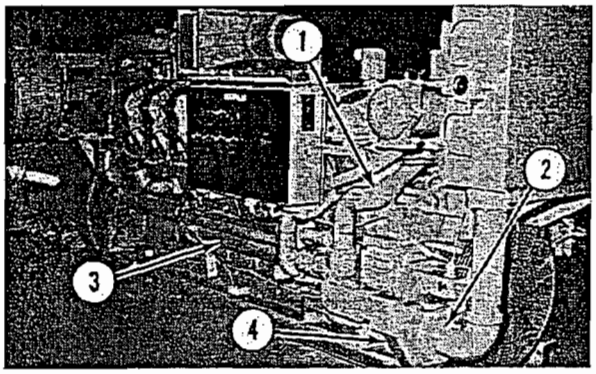


Figure 37. Right Side Of Engine
(1) Water line to front of engine cylinder block.
(2) Coolant inlet. (3) Oil cooler. (4) Water pump.

This system (Figure 37 & 38) uses a water pump (4) that is driven by the lower front right gear group. Coolant from a radiator or other heat exchanger is pulled into the coolant inlet (2) in the center of the water pump housing by the rotation of the water pump impeller. The coolant flow is then divided at the water pump outlet. Part of the coolant flow is sent through water line (1) to the front of the cylinder block and part is sent through the engine oil cooler (3).

Note: There is one opening on the pump outlet so that a remote pump can be connected to the system. The remote pump can be used if there is a failure of the water pump on the engine.

Coolant is sent through a water line to the front of the cylinder block and through a main distribution manifold to each cylinder water jacket. The main distribution manifold is located just above the main bearing oil gallery in the center of the cylinder block. Some of the coolant goes out the back of the cylinder block and into the adapter housing for the exhaust bypass valve. Flow from the exhaust bypass valve adapter housing is divided. Part of the coolant goes up through the exhaust elbow and part goes up through the turbocharger turbine housings. All coolant flow is then directed into the water cooled exhaust manifolds.

The coolant sent to the oil cooler goes through the oil cooler and flows into the water jacket of the block at the right rear cylinder. The cooler coolant mixes with the hotter coolant and goes to both sides of the block through the distribution manifolds connected to the water jacket of all the cylinders.

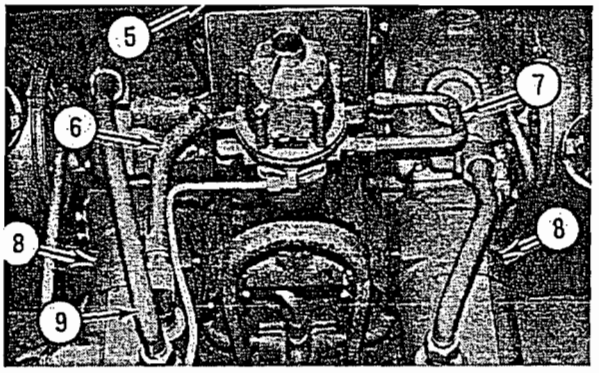


Figure 38. Coolant Flow From Rear of Engine
(5) Exhaust elbow. (6) Water line between exhaust elbow and exhaust manifold. (7) Water line between exhaust bypass valve guide and exhaust elbow.
(8) Water cooled exhaust manifold. (9) Water line between exhaust manifold and turbocharger turbine housing.

The coolant flows up through the water jackets and around the cylinder liners from the bottom to the top. Near the top of the cylinder liners, where the temperature is the hottest, the water jacket is made smaller. This shelf (smaller area) causes the coolant to flow faster for better liner cooling. Coolant from the top of the liners goes into the cylinder head which sends the coolant around the parts where the temperature in the cylinder head is the hottest. Coolant then goes to the top of the cylinder head and out through an elbow, one at each cylinder head, into the watercooled exhaust manifolds (8) (Figure 43) at each bank of cylinders. Coolant from the exhaust manifolds flows through lines (9) to cool the turbine side of the turbochargers. Coolant flows through line (6) to cool the exhaust elbow (5). Coolant flows through line (7) from the top of the cylinder block, cools the exhaust bypass valve guide and flows into the exhaust elbow. After cooling engine components the coolant flow is directed

through the exhaust manifolds to the temperature regulator (thermostat) housing.

The water temperature regulator housing is located at the top, front of the engine. It has an upper and lower flow section, and uses four temperature regulators. The sensing bulbs of the four temperature regulators are in the coolant in the lower section of the housing. Before the engine reaches operating temperatures and the regulators open, cold coolant is sent through the lower section of the housing and through the bypass line back to the inlet of the water pump. As the temperature of the coolant increases enough to make the regulators start to open, coolant flow in the bypass line is stopped and coolant is sent through the outlets to the radiator or heat exchanger.

Note: The water temperature regulator is an important part of the cooling system. It divides coolant flow between the heat exchanger and internal bypass of the water pump as necessary to maintain the correct temperature. If the water temperature regulator is not installed in the system, there is no mechanical control, and most of the coolant will take the path of least resistance through the bypass. This will cause the engine to overheat in hot weather. In cold weather, even the small amount of coolant that goes through the radiator is too much, and the engine will not get to normal operating temperatures.

Total system coolant capacity will depend on the size of the heat exchanger. Use a coolant mixture of 50 percent pure water and 50 percent permanent antifreeze, then add a concentration of 3 to 6 percent corrosion inhibitor.

Separate Circuit Aftercooler (SCAC) System

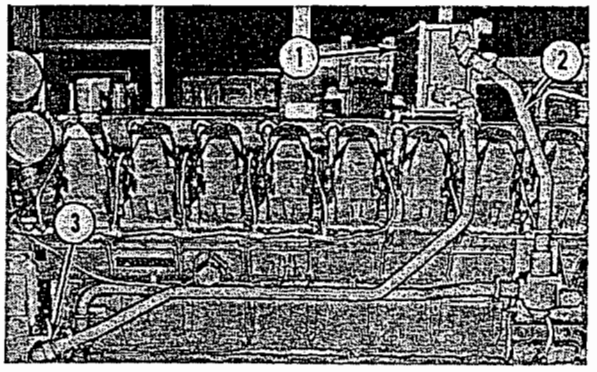


Figure 39. Left Side Of Engine
(1) Aftercooler. (2) Coolant return line. (3) Auxiliary Water pump.

Engines with a water cooled aftercooler, use a separate circuit aftercooler (SCAC) system instead of the normal jacket water circuit, to cool the air in the aftercooler. With the SCAC system, coolant is supplied from a separate radiator or heat exchanger.

With the engine running at less than operating temperature, the aftercooler coolant circuit is closed. The auxiliary water pump (3) sends coolant through a line to the aftercooler (1) at approximately 570 liter/m (150 U.S. gpm) (Figure 39). Coolant flows up through the core assembly and out of the aftercooler through the coolant return line (2), through a thermostatic valve and back to auxiliary water pump. As the coolant temperature increases, the thermostatic valve opens and coolant flow from the aftercooler core assembly is directed to a radiator or heat exchanger and then back to auxiliary water pump. The thermostatic valve will be fully open when the coolant temperature is 32°C (90°F) or 54°C (130°F) depending on the thermostat installed in the valve housing.

Note: Certain cogeneration engines do not use thermostats to control jacket water temperature. The engine temperature is controlled externally with a heat exchanger by maintaining the outlet temperature of the steam system. In high water temperature applications the oil cooler is on a separate circuit. A thermostat controls the oil temperature going to the bearings.

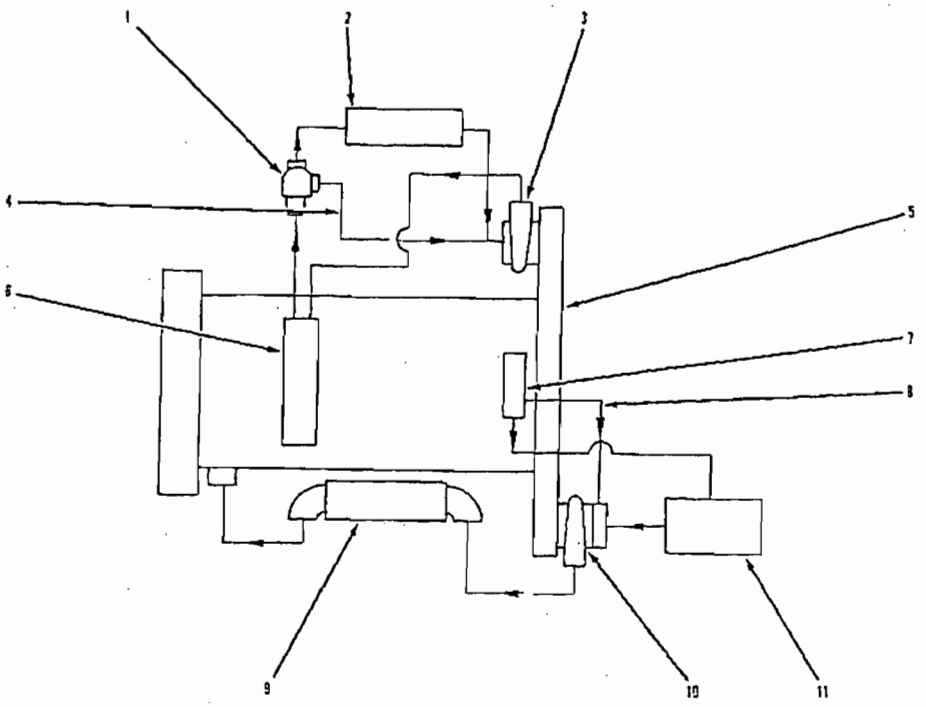


Figure 40. G3500 Cooling System Engine Schematic
Two circuit with two engine driven pumps
(1) Thermostatic valve (coolant temperature for aftercooler). (2) Heat exchanger (aftercooler). (3) Pump [aftercooler circuit (engine driven)]. (4) Bypass line (aftercooler). (5) Front housing. (6) Aftercooler. (7) Regulator housing. (8) Bypass line (jacket water). (9) Oil cooler. (10) Pump [jacket water/oil cooler circuit (engine driven)]. (11) Heat exchanger (jacket water/oil cooler).

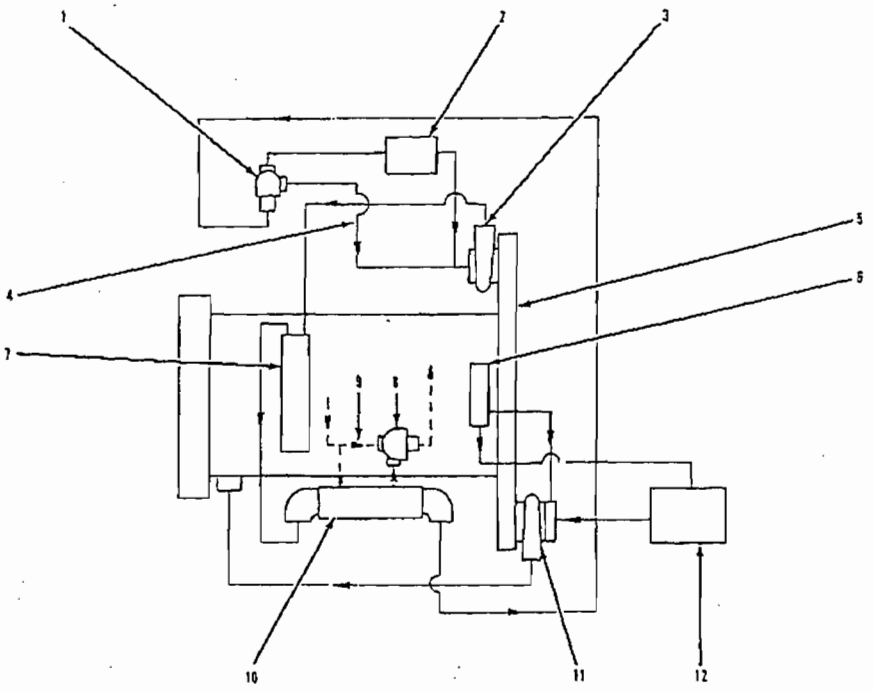


Figure 41. G3500 Landfill Cooling System Engine Schematic
Two circuit with two engine driven pumps (requires a large aftercooler/oil cooler heat exchanger).
(1) Thermostatic valve. (2) Aftercooler/oil cooler heat exchanger. (3) Pump [aftercooler/oil cooler circuit (engine driven)]. (4) Bypass line. (5) Front housing. (6) Regulator housing. (7) Aftercooler. (8) Thermostatic valve (oil temperature). (9) Bypass line. (10) Oil cooler. (11) Pump [jacket water circuit (engine driven)]. (12) Heat exchanger (jacket water).

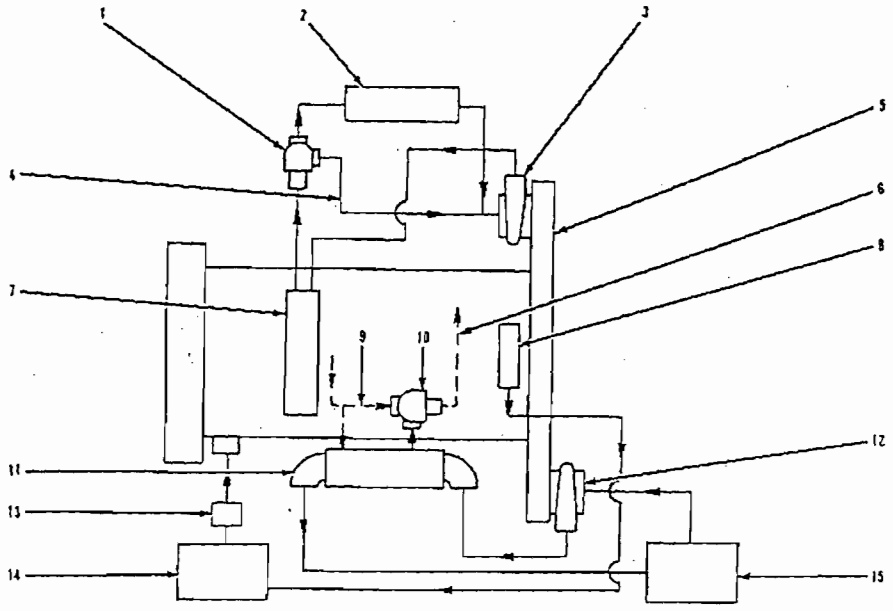


Figure 42. G3500 Cogeneration Cooling System Engine Schematic
Jacket water pump (customer supplied)
Three circuit with two engine driven pumps.
(1) Thermostatic valve. (2) Heat exchanger (aftercooler). (3) Pump [aftercooler circuit (engine driven)].
(4) Bypass line (aftercooler). (5) Front housing. (6) Oil line to oil filter. (7) Aftercooler. (8) Regulator housing.
(9) Bypass line (oil cooler). (10) Thermostatic valve (oil temperature). (11) Oil cooler. (12) Pump [oil cooler circuit (engine driven)]. (13) Pump [jacket water circuit (customer supplied)]. (14) Heat exchanger (jacket water).

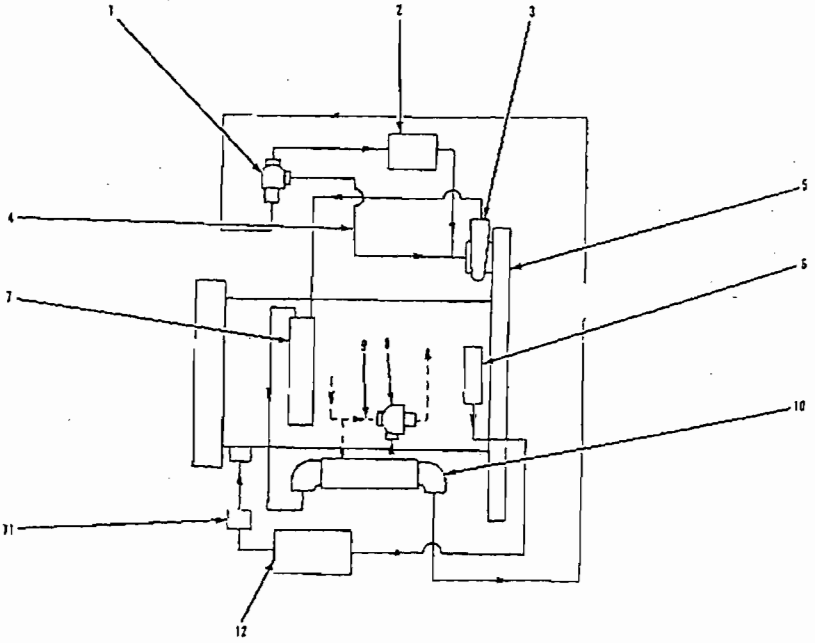


Figure 43. G3500 Cogeneration Cooling System Engine Schematic
Jacket water pump (customer supplied)
Two circuit with one engine driven pump (requires a large aftercooler/oil cooler heat exchanger).
(1) Thermostatic valve (coolant temperature for aftercooler). (2) Aftercooler/oil cooler heat exchanger.
(3) Pump [aftercooler/oil cooler circuit (engine driven)]. (4) Bypass line. (5) Front housing. (6) Regulator housing.
(7) Aftercooler. (8) Thermostatic valve (oil temperature). (9) Bypass line. (10) Oil cooler. (11) Pump [jacket water circuit (customer supplied)]. (12) Heat exchanger (jacket water).

Basic Block

Cylinder Block, Liners And Heads

The cylinders in the left side of the block make an angle of 60 degrees with the cylinders in the right side of the block. The main bearing caps are fastened to the block with four bolts per cap.

The cylinder liners can be removed for replacement. The top surface of the block is the seat for the cylinder liner flange. Engine coolant flows around the liners to keep them cool. Three O–ring seals around the bottom of the liner make a seal between the liner and the cylinder block. A filler band goes under the liner flange and makes a seal between the top of the liner and the cylinder block.

The engine has a separate cylinder head for each cylinder. Four valves (two intake and two exhaust), controlled by a push rod valve system, are used for each cylinder. Valve guides without shoulders are pressed into the cylinder heads. The opening for the spark plug is located between the four valves.

There is an aluminum spacer plate between each cylinder head and the block. Coolant goes out of the block through the spacer plate and into the head through eight openings in each cylinder head face. Grommets the width of the spacer plate prevent coolant leakage. Gaskets seal the oil drain passages between the head, spacer plate and block.

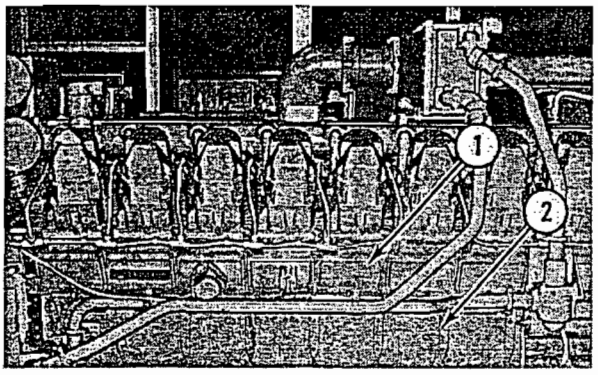


Figure 44. Left Side Of 3516 Engine
(1) Covers for camshaft and valve lifter inspection.
(2) Covers for crankshaft main and rod bearing inspection.

Covers (1) (Figures 45) allow access to the camshafts and valve lifters.

Covers (2) allow access to the crankshaft connecting rods, main bearings and piston cooling jets. With covers removed, all the openings can be used for inspection and service.

Pistons, Rings And Connecting Rods

The aluminum pistons have an iron band for the top two rings. This helps reduce wear on the compression ring grooves. The pistons have three rings; two compression rings and one oil ring. All the rings are located above the piston pin bore. The oil ring is a standard (conventional) type. Oil returns to the crankcase through holes in the oil ring groove. The top two compression rings are also the standard (conventional) type.

The connecting rod has a taper on the pin bore end. This gives the rod and piston more strength in the areas with the most load. Four bolts set at a small angle hold the rod cap to the rod. This design keeps the rod width and weight to a minimum, so that the largest possible rod bearing (and crank journal) can be used and the rod can still be removed through the top of the liner bore.

Crankshaft

The crankshaft changes the combustion forces in the cylinder into usable rotating torque which powers the engine. A vibration damper of the fluid type is used at the front of the crankshaft to reduce torsional vibrations (twist on the crankshaft) that can cause damage to the engine.

The crankshaft drives a group of gears on the front and rear of the engine. The gear group on the front of the engine drives the oil pump, water pump, fuel transfer pump, governor or governor actuator and two accessory drives. The gear group on the rear of the engine drives the camshafts.

Lip seals and wear sleeves are used at both ends of the crankshaft for easy replacement and a reduction of maintenance cost. Pressure oil is supplied to all main bearings through drilled holes in the webs of the cylinder block. The oil then flows through drilled holes in the crankshaft to provide oil to the connecting rod bearings. The crankshaft is held in place by five main bearings on the G3508, seven main bearings on the G3512, and nine main bearings on the G3516. A thrust plate at either side of the center main bearing controls the end play of the crankshaft.

Camshafts

The G3512 and G3516 have two camshafts per side that are doweled and bolted together to make a camshaft group. Each G3516 camshaft group is supported by nine bearings and is driven by the gears at the rear of the engine. Each G3512 camshaft group is supported by seven bearings and is driven by the gears at the rear of the engine. The G3508 has one camshaft per side. Each camshaft is supported by five bearings and is driven by the gears at the rear of the engine.

As the camshaft turns, each lobe moves a lifter assembly. There are two lifter assemblies for each cylinder. Each lifter assembly moves a push rod and two valves (either intake or exhaust). The camshafts must be in time with the crankshaft. The relation of the cam lobes to the crankshaft position cause the valves in each cylinder to operate at the correct time.

Electrical System

Engine Electrical System

The electrical system has three separate circuits: the charging circuit, the starting circuit and the low amperage circuit. Some of the electrical system components are used in more than one circuit. The battery (batteries), circuit breaker, ammeter, cables and wires from the battery are all common in each of the circuits.

The charging circuit is in operation when the engine is running. An alternator makes electricity for the charging circuit. A voltage regulator in the circuit controls the electrical output to keep the battery at full charge.

The starting circuit is in operation only when the start switch is activated.

The low amperage circuit and the charging circuit are both connected to the same side of the ammeter. The starting circuit connects to the opposite side of the ammeter.

Charging System Components

NOTICE

Never operate an alternator without a battery in the circuit. Making or breaking an alternator connection with heavy load on the circuit can cause damage to the voltage regulator.

Alternator (3T6352 & 4N3986)

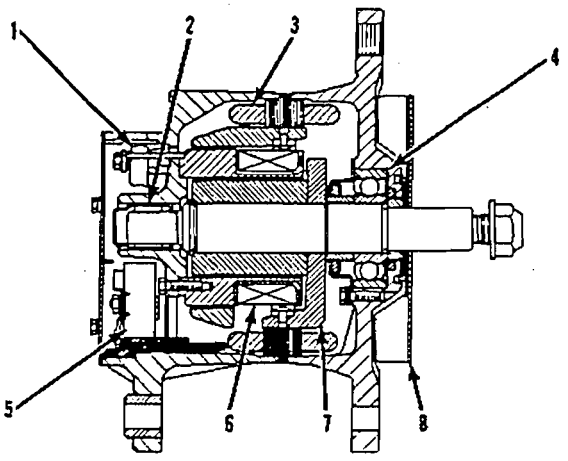


Figure 45. Alternator
(1) Regulator. (2) Roller bearing. (3) Stator winding. (4) Ball bearing. (5) Rectifier bridge. (6) Field winding. (7) Rotor assembly. (8) Fan.

The alternator (Figure 45) is driven by belts from the crankshaft pulley. This alternator is a three phase, self-rectifying charging unit, and the regulator (1) is part of the alternator.

This alternator design has no need for slip rings or brushes, and the only part that has movement is the rotor assembly (7). All conductors that carry current are stationary. The conductors are: the field winding (6), stator windings (3), six rectifying diodes, and the regulator circuit components.

The rotor assembly has many magnetic poles like fingers with air space between each opposite pole. The poles have residual magnetism (like permanent magnets) that produce a small amount of magnet-like lines of force (magnetic field) between the poles. As the rotor assembly begins to turn between the field winding and the stator windings, a small amount of alternating current (AC) is produced in the stator windings from the small magnetic lines of force made by the residual magnetism of the poles. This AC current is changed to direct current (DC) when it passes through the diodes of the rectifier bridge (5). Most of this current goes to charge the battery and to supply the low amperage circuit, and the remainder is sent on to the field windings. The DC current flow through the field windings (wires around an

iron core) now increases the strength of the magnetic lines of force. These stronger lines of force now increase the amount of AC current produced in the stator windings. The increased speed of the rotor assembly also increases the current and voltage output of the alternator.

The voltage regulator is a solid state (transistor, stationary parts) electronic switch. It feels the voltage in the system, and switches on and off many times a second to control the field current (DC current to the field windings) to the alternator. The output voltage from the alternator will now supply the needs of the battery and the other components in the electrical system. No adjustment can be made to change the rate of charge on these alternator regulators.

Grounding Practices

Proper grounding for vehicle and engine electrical systems is necessary for proper vehicle performance and reliability. Improper grounding will result in uncontrolled and unreliable electrical circuit paths which can result in damage to main bearings and crankshaft journal surfaces. Uncontrolled electrical circuit paths can also cause electrical noise which may degrade vehicle and radio performance.

To insure proper functioning of the vehicle and engine electrical systems, and engine-to-frame ground strap with a direct path to the battery must be use. This may be provided by way of a starting motor, a frame to starting motor ground, or a direct frame to engine ground.

Ground wires/straps should be combined at ground studs dedicated for ground use only. The engine alternator must be battery (-) grounded with a wire size adequate to handle full alternator charging current.

NOTICE

This engine may be equipped with a 24 volt starting system. Use only equal voltage for boost starting. The use of a welder or higher voltage will damage the electrical system.

Starting Systems

There are two types of starting systems available for Caterpillar Engines — air and electric.

The choice of systems depends on availablility of the energy source. Availablity of space for energy of storage and ease of recharging the energy banks are considerations for determining the type of starting system to be used.

Electric

Electric starting (Figure 46) is the most convenient to use. It is least expensive and is most adaptable for remote control and automation.

Batteries

Batteries provide sufficient power to crank engines long and fast enough to start. Lead-acid types are common, have high output capabiliites, and lowest first cost. Nickel-cadmium batteries are costly, but have long shelf life and require minimum maintenance. Nickel-cadmium types are designed for long life and may incorporate thick plates which decrease high discharge capability. Consult the battery supplier for specific recommendations.

Two considerations in selecting proper battery capacity are:

- The lowest temperature at which the engine might be cranked.
- The parasitic load imposed on the engine. A good rule of thumb is to select a battery package which will provide at least four 30 second cranking periods (total of 2 minutes cranking). An engine should not be cranked continuously for more than 30 seconds or starter motors may overheat.

Ambient temperatures drastically affect battery performance and charging efficiencies. Maintain 32°C (90°F) maximum temperature to assure rated output. Impact of colder temperatures is described in Figure 47.

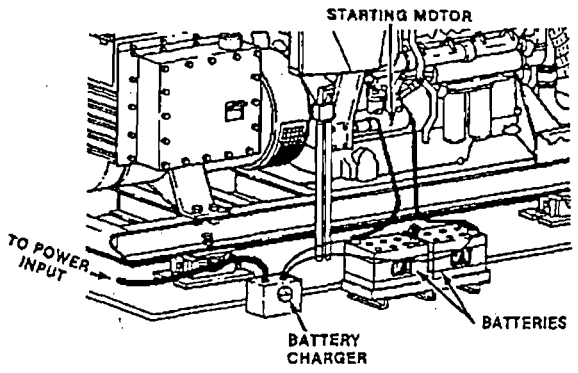


Figure 46. Electric starting system.

Temperature vs. Output		
°F	°C	27°C (80°F) Ampere Hours Output Rating
80	28	100
32	0	65
0	-18	40

Figure 47. Impact of Cold Temperatures.

Locate cranking batteries for easy visual inspection and maintence. They must be away from flame or spark sources and isolated from vibration. Mount level on nonconducting material and protect from splash and dirt. Use short slack cable lengths and minimize voltage drops by positioning batteries near the starting motor.

Disconnect the battery charger when removing or connecting battery leads. Solid-state equipment, i.e., electronic governor, speed switches, can be harmed if subjected to charger's full output.

Battery Charger

Various chargers are available to replenish a battery. Trickle chargers are designed for continuous service on unloaded batteries. They automatically shut down to milliampere current when batteries are fully charged.

Overcharging shortens battery life and is recognized by excessive water loss. Conventional lead-acid batteries require less than 2 oz. (59.2 mL) make-up water during 30 hours of operation.

Float-equalize chargers are more expensive than trickle chargers are used in applications demanding maximum battery life. These chargers include line and load regulation, and current limiting devices, which permit continuous loads at rated output.

Both trickle chargers and float equalize chargers require a source of A/C power while the engine is not running. Chargers must be capable of limiting peak currents during cranking cycles or have a relay to disconnect during cranking cycles. Where engine-driven alternators and battery chargers are both used, the disconnect relay usually disconnects the battery charger during engine cranking and running.

Engine-driven generators or alternators can be used, but have the disadvantage of charging batteries only while the engine runs. Where generator sets are subject to many starts, insufficent battery capacity could threaten dependability.

Solenoid

A solenoid (Figure 48) is a magnetic switch that does two basic operations:

a. Closes the high current starter motor circuit with a low current start switch circuit.

b. Engages the starter motor pinion with the ring gear.

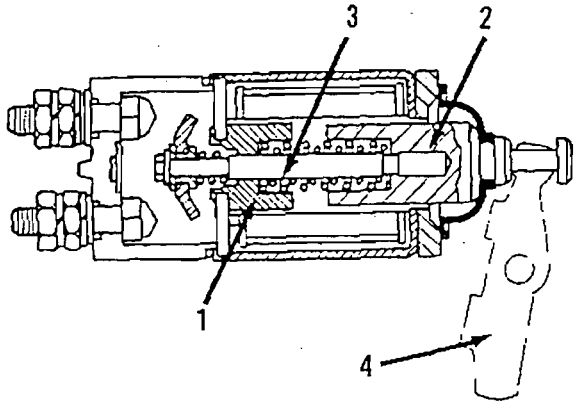


Figure 48. Solenoid Schematic.
(1) Electromagnet. (2) Hollow cylinder. (3) Plunger. (4) Shift lever.

The solenoid switch is made of an electromagnet (one or two sets of windings) (1) around a hollow cylinder (2). There is a plunger (core) (3) with a spring load inside the cylinder that can move forward and

backward. When the start switch is closed and electricity is sent through the windings, a magnetic field is made that pulls the plunger forward in the cylinder. This moves the shift lever(4) (connected to the rear of the plunger) to engage the starter pinion drive gear with the ring gear. The front end of the plunger then makes contact across the battery and motor terminals of the solenoid, and the starter motor begins to turn the flywheel of the engine.

When the start switch is opened, current no longer flows through the windings. The spring now pushes the plunger back to the original position, and, at the same time, moves the pinion gear away from the flywheel.

When two sets of windings in the solenoid are used, they are called the hold-in winding and the pull-in winding. Both have the same number of turns around the cylinder, but the pull-in winding uses a larger diameter wire to produce a greater magnetic field. When the start switch is closed, part of the current flows from the battery through the hold-in windings, and the rest flows through the pull-in windings to motor terminal, then through the motor to ground. When the solenoid is fully activated (connection across battery and motor terminal is complete), current is shut off through the pull-in windings. Now only the smaller hold-in windings are in operation for the extended period of time it takes to start the engine. The solenoid will now take less current from the battery, and heat made by the solenoid will be kept at an acceptable level.

Starter Motor

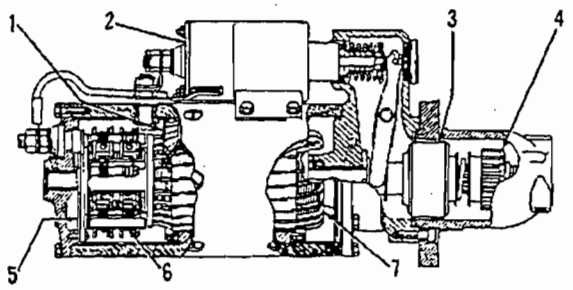


Figure 49. Starter Motor Cross Section
(1) Field. (2) Solenoid. (3) Clutch. (4) Pinion.
(5) Commutator. (6) Brush assembly. (7) Armature.

The starter motor (Figure 49) is used to turn the engine flywheel fast enough to get the engine running.

The starter motor has a solenoid(2). When the start switch is activated, the solenoid will move the starter pinion(4) to engage it with the ring gear on the flywheel of the engine. The starter pinion will engage with the ring gear before the electric contacts in the solenoid close the circuit between the battery and the starter motor. When the circuit between the battery and the starter motor is complete, the pinion will turn the engine flywheel. A clutch (3) gives protection for the starter motor so that the engine cannot turn the starter motor too fast. When the start switch is released, the starter pinion will move away from the ring gear.

Circuit Breaker

The circuit breaker (Figure 50) is a switch that opens the battery circuit (5) if the current in the electrical system goes higher than the rating of the circuit breaker.

A heat activated metal disc (4) with a contact point (3) completes the electric circuit through the circuit breaker. If the current in the electrical system gets too high, it causes the metal disc to get hot. This heat causes a distortion of metal disc which opens the contacts (2)and breaks the circuit. A circuit breaker that is open can be reset after it cools. Push the reset button (1) to close the contacts and reset the circuit breaker.

NOTICE

Find and correct the problem that causes the circuit breaker to open. This will help prevent damage to the circuit components from too much current.

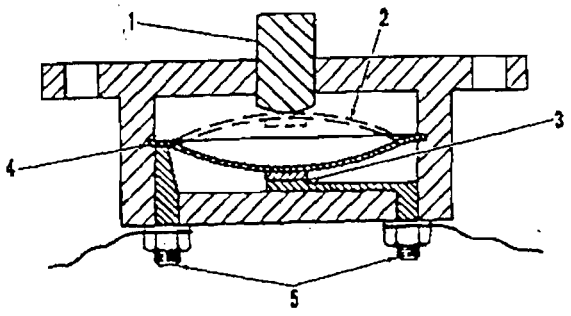


Figure 50. Circuit Breaker Cross Section
(1) Reset button. (2) Disc in open position. (3) Contacts. (4) Disc. (5) Battery circuit terminals.

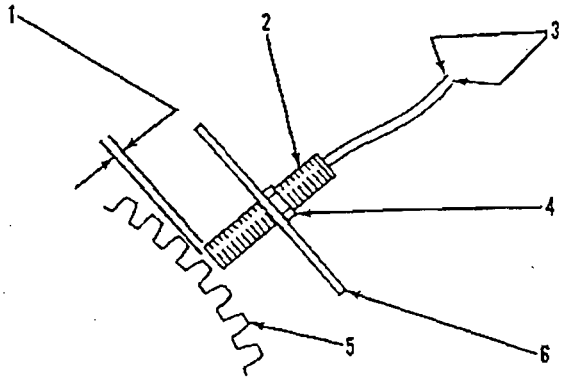


Figure 51. Magnetic Pickup
(1) Clearance dimension. (2) Pole piece. (3) Wire Coils. (4) Locknut. (5) Gear tooth. (6) Housing.

Magnetic Pickup

The magnetic pickup (Figure 51) is a single pole, permanent magnet generator made of wire coils (2) around a permanent magnet pole piece (4). As the teeth of the flywheel ring gear (5) cut through the magnetic lines of force around the pickup, an AC voltage is generated. The frequency of this voltage is directly proportional to engine speed.

Magnetic Switch

A magnetic switch (relay) is used for the starter solenoid circuit. Its operation electrically, is the same as the solenoid. Its function is to reduce the low current load on the start switch and control low current to the starting motor solenoid.

Water Temperature Connector Switch

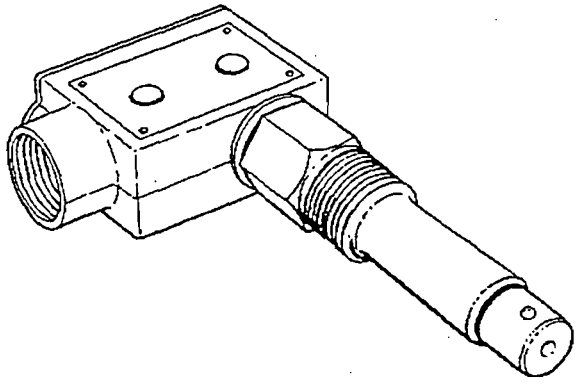


Figure 52. Water Temperature Contactor Switch

The contactor switch for water temperature (Figure 52) is installed in the regulator housing. No adjustment to the temperature range of the contactor can be made. The element feels the temperature of the coolant and then operates the micro switch in the contactor when the coolant temperature is too high. The element must be in contact with the coolant to operate correctly. If the reason for the engine being too hot is caused by low coolant level or no coolant, the contactor switch will not operate.

The contactor switch is normally connected to the electric shutoff system to stop the engine. The switch can also be connected to an alarm system. When the temperature of the coolant lowers again to the operating range, the contactor switch opens automatically.

Air Inlet Temperature Switch

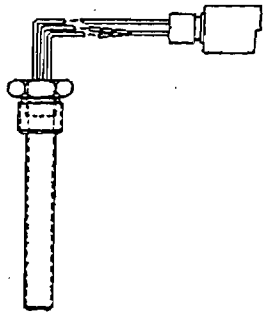


Figure 53. Air Inlet Temperature Switch.

The contactor switch for air inlet temperature (Figure 53) is installed in the inlet air manifold. No adjustment to the temperature range of the contactor can be made. The element feels the temperature of the inlet air and then operates the micro switch in the contactor when the inlet air temperature is too high. The element must be in contact with the inlet air to operate correctly.

The contactor switch is normally connected to the electric shutoff system to stop the engine. The switch can also be connected to an alarm system. When the temperature of the inlet air lowers again to the operating range, the contactor switch opens automatically.

Air Start

The air starting motor (Figures 54-56) is used to turn the engine flywheel fast enough to get the engine running.

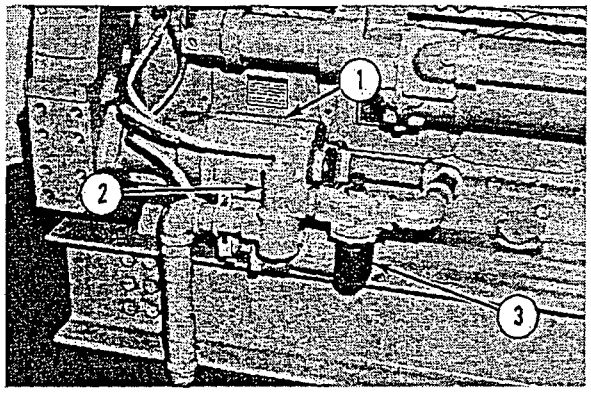


Figure 54. Typical Air Starting System
(1) Air starting motor. (2) Relay valve. (3) Oiler.

The air starting motor (1) can be mounted on either side of the engine. Air is normally contained in a storage tank and the volume of the tank will determine the length of time the engine flywheel can be turned. The storage tank must hold this volume of air at 1720 kPa (250 psi) when filled.

For engines which do not have heavy loads when starting, the regulator setting is approximately 690 kPa (100 psi). This setting gives a good relationship between cranking speeds fast enough for easy starting and the length of time the air starting motor can turn the engine flywheel before the air supply is gone.

If the engine has a heavy load which can not be disconnected during starting, the setting of the air pressure regulating valve needs to be higher in order to get high enough speed for easy starting.

The air consumption is directly related to speed; the air pressure is related to the effort necessary to turn the engine flywheel. The setting of the air pressure regulator can be up to 1030 kPa (150 psi) if necessary to get the correct cranking speed for a heavily loaded engine. With the correct setting, the air starting motor can turn the heavily loaded engine as fast and as long as it can turn a lightly loaded engine.

Other air supplies can be used if they have the correct pressure and volume. For good life of the air starting motor, the supply should be free of dirt and water. A lubricator with SAE 10 non detergent oil [for temperatures above 0°C (32°F)], or air tool oil, #1 diesel fuel or equivalent [for temperatures below 0°C (32°F)] should be used with the starting system. The maximum pressure for use in the air starting motor is 1030 kPa (150 psi).

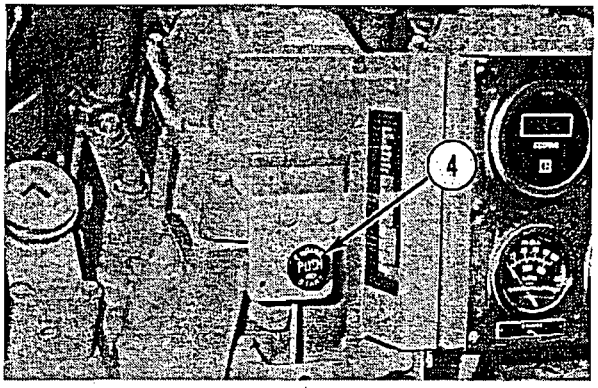


Figure 55. Typical Air Start Installation
(4) Air start control valve.

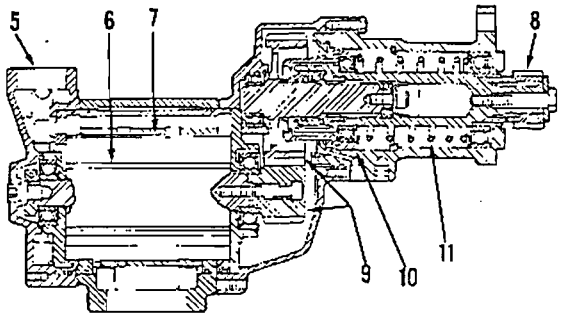


Figure 56. Air Starting Motor
(5) Air inlet. (6) Vanes. (7) Rotor. (8) Pinion. (9) Gears. (10) Piston. (11) Piston spring.

The air from the supply goes to relay valve (2). The start control valve (4) (Figure 56) is connected to the line before the relay valve. The flow of air is stopped by the relay valve until the start control valve is activated. The air from the start control valve goes to piston (10) behind pinion (8) for the starting motor. The air pressure on the piston puts spring (11) in compression and puts the pinion in engagement with the flywheel gear. When the pinion is in engagement, air can go out through another line to the relay valve. The air activates relay valve which opens the supply line to the air starting motor.

The flow of air goes through the oilerr (3) where it picks up lubrication for the air starting motor.

The air with lubrication goes into the air motor through air inlet (5). The pressure of the air pushes against vanes (6) in rotor (7), and then exhausts through the outlet. This turns the rotor which is connected by gears (9) and a drive shaft to the starting motor pinion(8) which turns the engine flywheel.

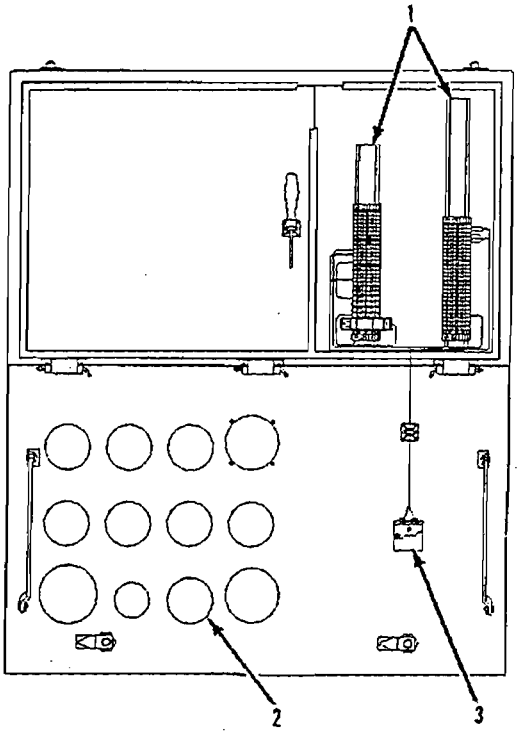
When the engine starts running, the flywheel will start to turn faster than the starting motor pinion. The pinion retracts under this condition. This prevents damage to the motor, pinion or flywheel gear.

When the start control valve is released, the air pressure and flow to the piston behind the starting motor pinion is stopped, the piston spring retracts the pinion. The relay valve stops the flow of air to the air starting motor.

Engine Monitoring and Shutdown Protection

G3500 Engines can be configured to use one of three systems to monitor engine parameters and provide engine shutdown protection: Junction Box (Energize To Shutdown), Junction Box (Energize To Run), and/or a Control Panel (Status Control). For detailed information on the operation, troubleshooting and engine control panel set-up, refer to SENR6420, Systems Operation Testing & Adjusting, Remote Control Panel (Status) For G3500 Engines (EIS).

Junction Box



Fgure 57. Junction Box (Shown With Door Open) (1) Terminal strips. (2) Gauges. (3) Emergency stop switch.

The junction box (1) (Figure 57)provides a central location to mount the various gauges, meters, indicators and switches available for use on the engine. It also contains space for the electrical terminal strips (2) that connect the sensors, pick-ups and relays to the gauges (3). The junction box is also used to provide shutoff protection for the engine.

An Emergency Stop Push Button (ESPB) may be located on the junction box panel. When this button (3) is pressed, the fuel is shut off and the engine ignition is turned off (the ground to the shutdown switch of the Electronic Ignition System control is opened).

To restart the engine, the ESPB must be turned until it pops out.

NOTICE

The Emergency Stop Push Button (ESPB) is **not to be used for normal engine shutdown.** To avoid possible engine damage, use the Engine Control Switch (ECS) for normal engine shutdown.

If the junction box is configured for an Energized To Run (ETR) or an Energized To Shutoff (ETS) application, a gas shutoff valve will be included in the engine installation. In an Energize To Run set up, the gas shutoff valve must remain energized to operate the engine. In the most common Energized To Shutoff system, the gas shutoff valve has a mechanical (manual) latch that must be set. If a fault is detected, the gas shutoff valve will be energized to unlatch the gas shutoff valve and start a two stage shutoff sequence.

The junction box is used to monitor engine oil pressure, coolant temperature, starting motor overspeed, and engine overspeed conditions.

Note: If the junction box monitors an overspeed condition, or if the Emergency Stop Push Button is activated, a relay will be energized and cut ignition to the engine.

Note: If the junction box monitors a loss of engine oil pressure, or detects a high coolant temperature, a relay will shut the fuel off to the engine.

Engine Start/Stop Panel

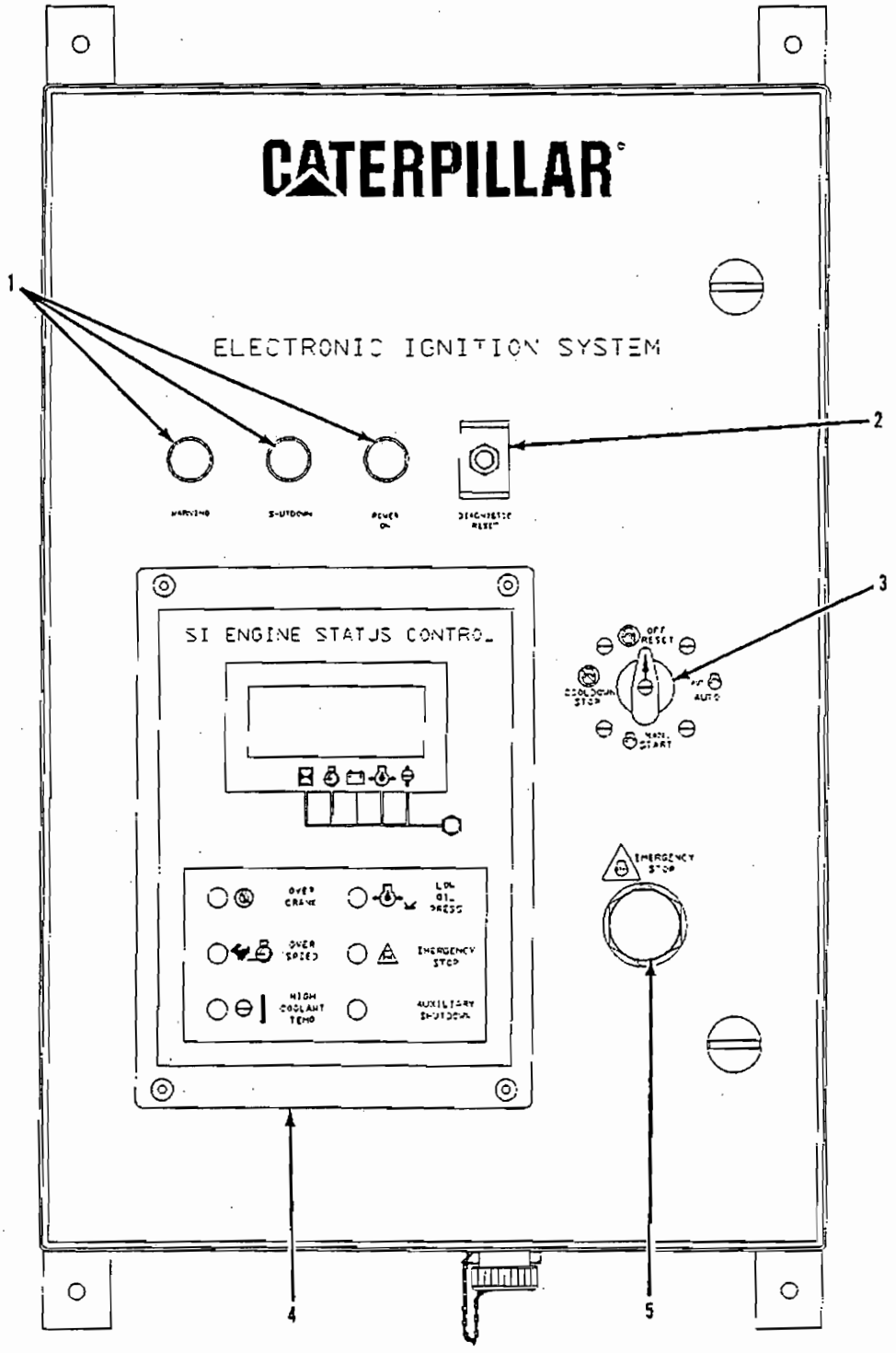


Figure 58. Engine Start/Stop Panel
(1) Indicator lights. (2) Diagnostic reset plug. (3) Engine Control Switch (ECS). (4) Status control module. (5) Emergency Stop Push Button (ESPB).

Engine Control Switch

The Engine Control Switch (ECS) (3) of the control panel has four positions – AUTO, MANUAL START, COOLDOWN/STOP, OFF/RESET. See Figure 58. If the ECS is in the AUTO position and a signal to run is received from a remote initiate contact (IC), or the ECS is placed in the MANUAL/START position, the engine will crank, terminate cranking and run. Engines equipped with electronic governors will run at low idle speed until lube oil pressure has exceeded the idle low oil pressure set point, then the relay contact of the governor control will close and the engine will accelerate to rated speed. Engines with hydra-mechanical governors will accelerate to their speed setting immediately after crank termination. The engine will run until the Engine Control Switch (ECS) is turned to COOLDOWN/STOP, OFF/RESET, or the remote initiate contact opens. Once the ECS is moved to the COOLDOWN/STOP position, or if in the AUTO position and the remote initiate contact opens, the engine will run at a lower speed for a short period of time, if the cool down feature was selected using the DDT. If the cool down feature was not programmed the engine will shut down immediately. The engine is then capable of immediate restart.

When the engine is to be shutdown, either manually (through the engine control switch) or automatically (through the engine protection system), a two stage shutdown sequence will occur. First, a relay will de-energize the gas shutoff valve, and will shut the fuel off to the engine. In the second step of the shutdown sequence the ground to the shutdown switch of the Electronic Ignition System control is opened.

Emergency Stop Push Button

An Emergency Stop Push Button (ESPB) (5) is located on the Engine Start/Stop Panel. A second Emergency Stop Push Button is located on the engine itself (junction box), when a remote start/stop panel is used. When this button is pressed, the fuel is shut off and the engine ignition is turned off (the ground to the shutdown switch of the Electronic Ignition System control is opened). To restart the engine, the ESPB must be turned until it pops out.

NOTICE

The Emergency Stop Push Button (ESPB) **is not to be used for normal engine shutdown.** To avoid possible engine damage, use the Engine Control Switch (ECS) for normal engine shutdown.

Fuel Selector Switch

The Fuel Selector Switch (optional) is a two position switch which provides input to the Electronic Ignition System Control Module. Two selections can be made with the switch. One position is for use with propane fuel only. The other position is for any other fuel used. Use of the PROPANE position signals the EIS Control Module to increase the range of timing retard because of the heat value of propane gas.

Status Control Module

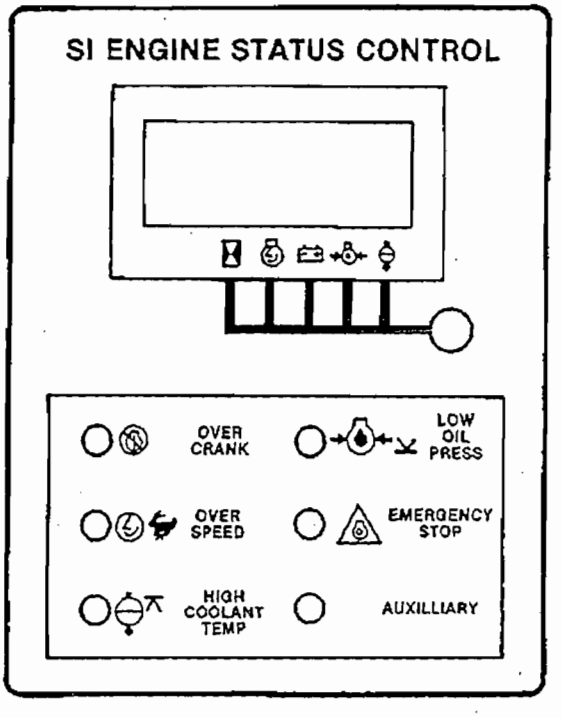


Figure 59. Status Control Module (SCM)

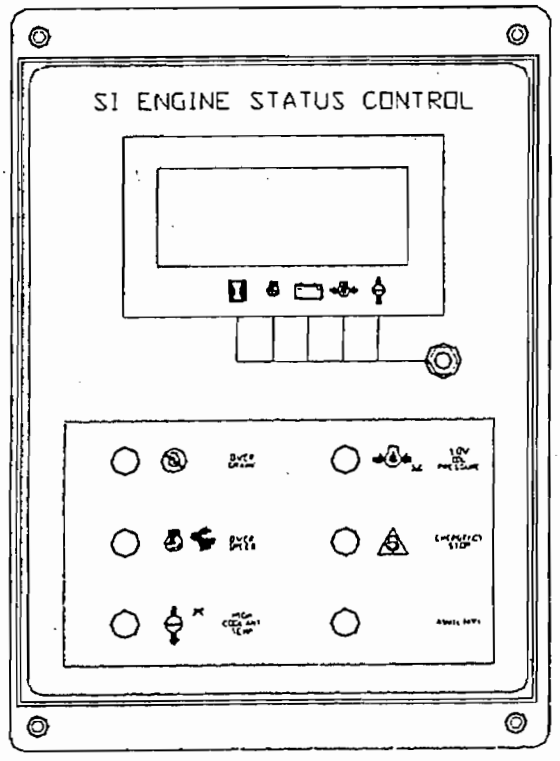
The Engine Status Control Module (SCM) (Figure 59) is used to monitor engine parameters (oil pressure, coolant temperature,

engine overspeed and over cranking of the starter motor). It also provides an engine protection system (two stage shutdown) and controls normal start/stop functions. When a fault signal is detected, the display is also used to indicate diagnostic codes, to aid in troubleshooting.

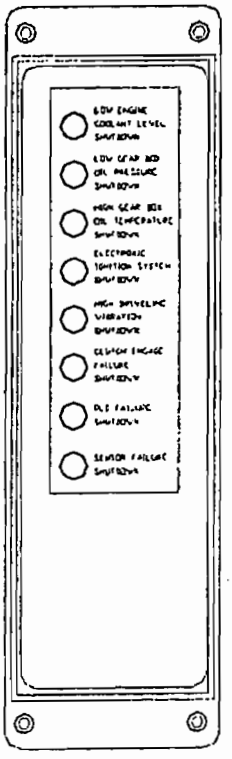
The Status Control Module contains a relay, terminal strips and overspeed verify.

DC Control Panel for Gas Engine Chiller

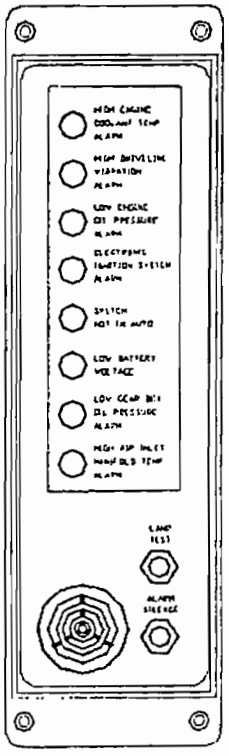
Status Control Module

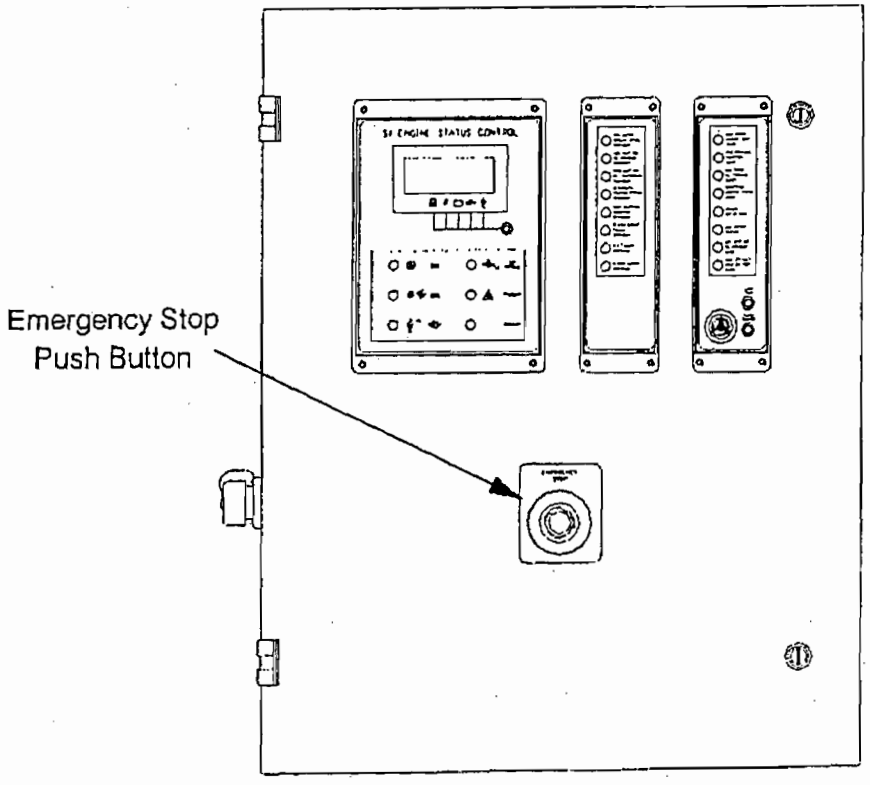


Indicator Module

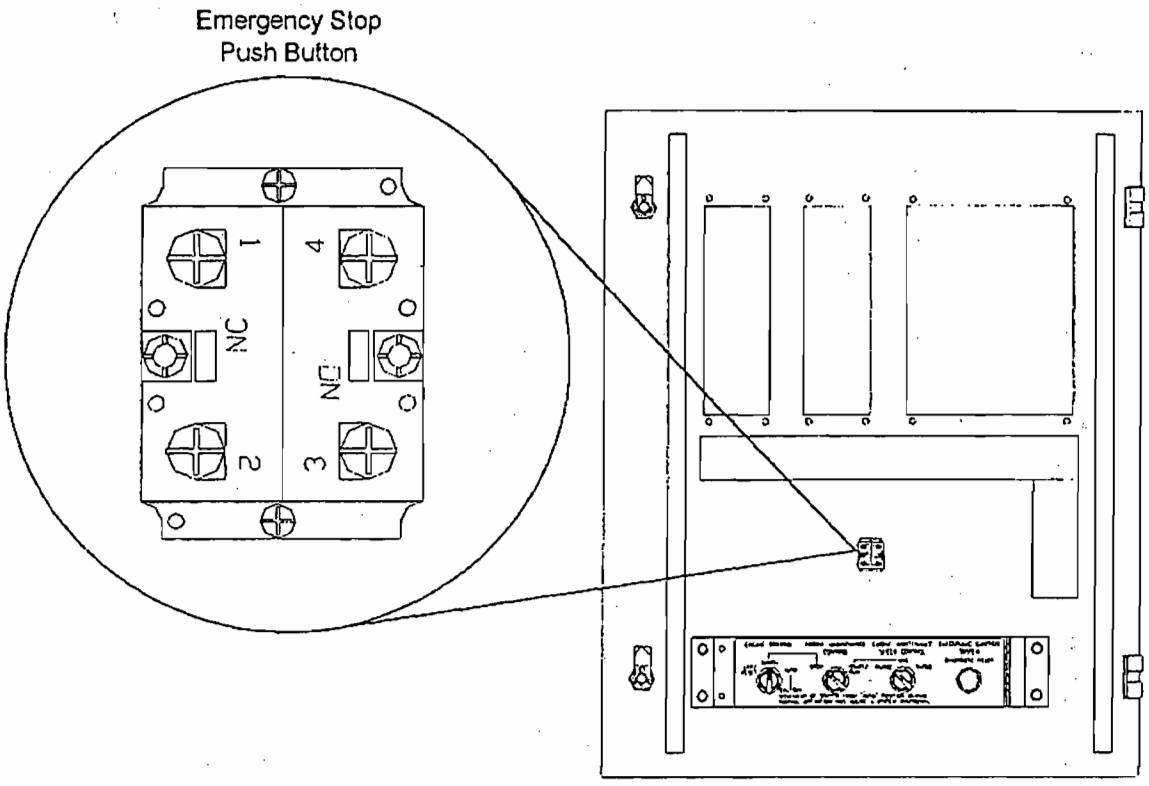


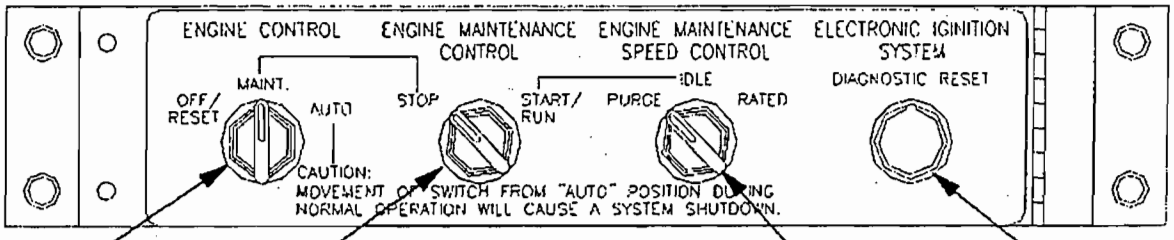
Alarm Module





DC Control Panel for Gas Engine Chiller (Inside View)





Engine Control Switch

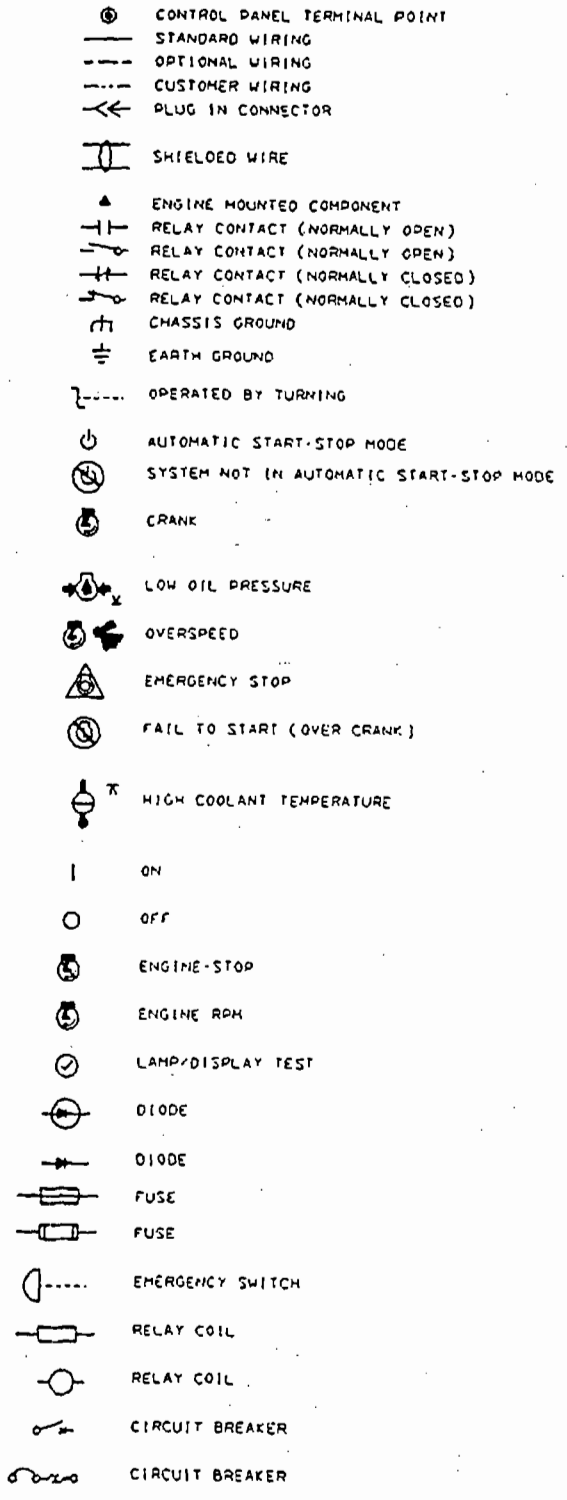
Engine Maintenance Control Switch

Engine Maintenance Speed Control Switch

Diagnostic Reset Switch

Abbreviations and Symbols

ALT	ALTERNATOR
ASSV	AIR START SOLENOID VALVE
AWG	AMERICAN WIRE GAUGE
BATT	BATTERY
C	COMMON
CAS	CRANK ANGLE SENSOR
CB	CIRCUIT BREAKER
CSPS	CUSTOMER SHUTDOWN POWER SUPPLY
CTR	CRANK TERMINATION RELAY
D	DIODE
DDTC	DIGITAL DIAGNOSTIC TOOL CONNECTOR
ECM	ENGINE CONTROL MODULE
ECS	ENGINE CONTROL SWITCH
ESPB	EMERGENCY STOP PUSH BUTTON
EXTP	COOLANT TEMPERATURE PROBE
F	FUSE
FCR	FUEL CONTROL RELAY
GSOV	GAS SHUTOFF VALVE
LHDS	LEFT HAND DETONATION SENSOR
MAN	MANUAL
MGR	MAGNETIC GROUNDING RELAY
PS	PINION SOLENOID
RHDS	RIGHT HAND DETONATION SENSOR
SCM	ENGINE STATUS CONTROL MODULE
SEC	SECOND
SIG	SIGNAL
SM	STARTING MOTOR
SMMS	STARTING MOTOR MAGNETIC SWITCH
SMR	STARTING MOTOR RELAY
XDUCER	TRANSDUCER



CATERPILLAR®

G3500-G3300
Ignition Systems

Variable Timing for Dual Fuel
Ignition Systems in Hazardous Locations
Engine Shutdown
Power for Auxiliary Panels
Spark Plugs

Materials and specifications are
subject to change without notice.

Printed in U.S.A.

Ignition Systems

Caterpillar Gas Engines use a low tension ignition system. Individual ignition transformers are mounted near the spark plug for each cylinder. Each engine is equipped with a solid-state magneto or an Electronic Ignition System (EIS) to provide a flexible ignition system requiring less maintenance and more reliability than older breaker-point magnetos.

Figure 1 is a diagram showing the major components of the Caterpillar Electronic Ignition System (EIS). The EIS system monitors engine operation and distributes power to the cylinder transformers, to provide the best engine performance at all engine speeds. It provides detonation protection and precision spark control for each cylinder.

Gas Engines with EIS incorporate a control system that senses and reacts to combustion detonation by controlling ignition timing. An accelerometer and electronic buffer unit is mounted on each side of the cylinder block, and is used to sense the detonation level (if any). When a level of detonation is reached that might damage the engine, the electronic timing control retards the ignition timing six degrees. If the engine continues to detonate, the control will provide a signal to shut the engine down. If the retarded timing successfully stops the detonation, the timing control will begin advancing the timing at a rate of 1 degree per minute up to the original timing. The timing control will stop advancing if detonation begins again. This allows the engine to obtain optimum fuel consumption by running close to detonation without damaging the engine.

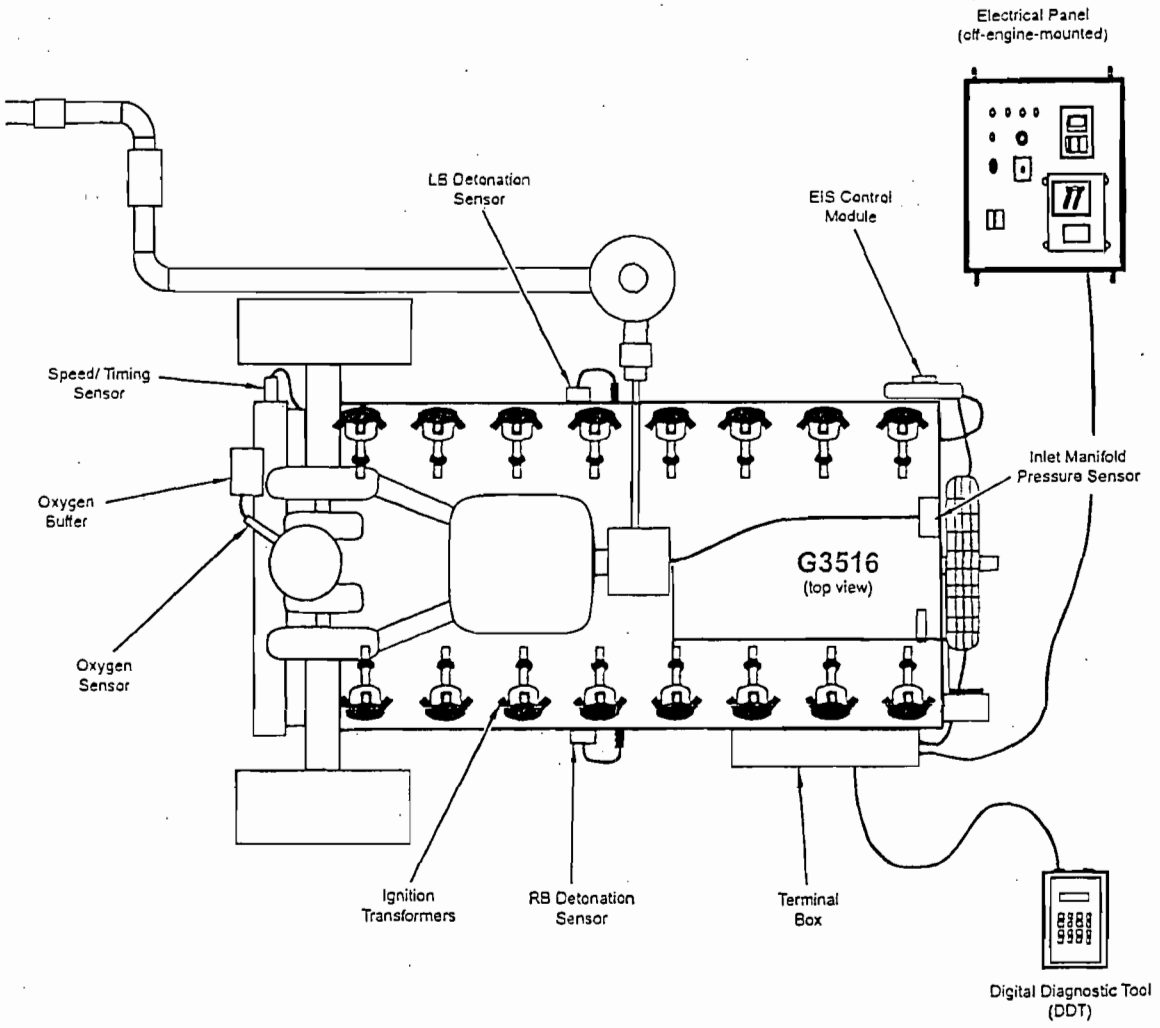


Figure 1.

The EIS control module sets engine timing according to desired engine timing, customer specified parameters, and the conditions in which the engine operates. Timing is automatically adjusted according to speed/timing maps, manifold air pressure, and any detonation. The control module also creates diagnostic codes if a problem develops in a component or harness.

EIS ignition transformers are located under the cylinder valve cover. The EIS control module sends a pulse to the primary coil of the ignition transformer to initiate combustion in each cylinder. The transformer steps up the voltage to create an arc across the spark plug gap. The cylinder valve cover acts as the ground for the ignition transformer.

Engine sensors provide information to the EIS control module. Detonation sensors are located on each side of the engine and continually monitor the engine for combustion detonation. A speed/timing sensor provides accurate spark timing and engine speed information. A special speed/timing ring is located on the rear, left camshaft on G3500 engines or on the front of G3400 camshafts. An intake manifold air pressure sensor provides engine load information.

The timing is set by connecting the Caterpillar Digital Diagnostic Tool (DDT) to the engine to electronically set the timing. The DDT is available through the price list. The DDT is also used to monitor engine speed, detonation level (if any), and diagnostic codes.

Variable Timing for Dual Fuel

The recommended timing varies with fuel composition. Serious engine damage could result if the timing is not changed when the fuel is switched for example, from natural gas to propane or digester to natural gas. To allow automatic timing adjustment when the fuel is changed, EIS offers a dual timing switch. A dual timing magneto is available as well.

The timing is automatically changed by an electrical signal, usually generated by falling pressure in the primary fuel. The customer must provide the external contacts to signal EIS or the magneto. See the "Fuel Systems" section of this guide for additional information.

Ignition Systems in Hazardous Locations

Engines installed in hazardous locations generally fall under the Class I Division 2 category of Article 500 of the National Electrical Code. It reads:

"A Class I, Division 2 location is a location:

1. in which volatile flammable liquids or flammable gases are handled, processed, or used, but in which the liquids, vapors, or gases will normally be confined within closed containers or closed systems from which they can escape only in case of accidental rupture or breakdown of such containers or systems, or in case of abnormal operation of the ventilation equipment; or
2. in which ignitable concentrations of gases or vapors are normally prevented by positive mechanical ventilation, and which might become hazardous through failure or abnormal operation of the ventilation equipment; or
3. that is adjacent to a Class I, Division 1 location, and to which ignitible concentrations of gases or vapors might occasionally be communicated unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air, and effective safeguards against ventilation failure are provided."

Basic difference between Division 1 and Division 2 is:

- Division 1 – flammable gases are always present.
- Division 2 – flammable gases may be present.

When an engine is installed in such a location, shielding of the ignition system wiring or usage of approved ignition system components may be required. Many Caterpillar Gas Engines have attachments providing an ignition system that is CSA approved for Class I, Division 2,GpD, locations. CSA approval is a Canadian requirement for engines operating in hazardous locations in Canada. CSA approval is also recognized in Division 2 locations outside Canada. Consult factory for availability.

The basis for the CSA attachment design is to either prevent hazardous atmosphere from coming in contact with arcing or sparking devices or to contain an explosion, within the engine itself. This is accomplished on Caterpillar Gas Engines by special metal conduit harness assemblies for the ignition system and engine wiring harnesses. Special explosion-proof transformers and cylinder head components have been developed to contain any potential explosion in the head.

The Caterpillar EIS system is available in a CSA approved configuration. This system varies from the standard EIS system by offering special ignition coils and a terminal box located on top of the EIS control module.

With the CSA system, no shutoffs, monitoring systems, start/stop logic or gas shutoff valves are provided. The functions must be provided by the customer. The required shutoffs are jacket water temperature (104°C, 220°F), oil pressure (15 psig at low idle, 40 psig above 1000 rpm), and overspeed (lesser of 10% above maximum engine speed or maximum driven equipment speed).

The CSA terminal box contains warning, shutdown, and power lamps and a diagnostic reset switch. All of these may be remote mounted by the customer.

For magneto systems with the CSA attachment, troubleshooting can be more difficult. A standard transformer can be installed temporarily so that a timing light can be triggered from the exposed high tension lead. Detecting a misfiring cylinder is more of a problem with a shielded system. Installation of normally closed switches in the primary wiring is one method of temporarily interrupting ignition to identify a misfiring cylinder. *If devices are incorporated in the shielded system for troubleshooting purposes, the primary of the magneto must never be grounded to interrupt the ignition.* This would most likely cause failure of solid-state components within the magneto.

Engine Shutdown

Accomplish normal shutdown by shutting off the fuel supply. This allows the engine to consume the fuel trapped between the shutoff valve and cylinder. It also prevents raw fuel from being pumped into the exhaust system. Raw fuel in a hot exhaust system presents the potential for explosion. Stopping the ignition system to cause engine shutdown should be utilized only for emergencies.

Power for Auxiliary Panels

Applications not having a 24 VCD electrical power source, such as gas compressors at remote sights, must find some source of electricity to power auxiliary panels. The power source has often been magneto.

Unlike most other engines, no pin is provided on the G3500 LE magneto for auxiliary power. This engine requires all the magneto power available in order to operate the ignition system. The electronic nature of its control system requires that a 24 VDC power source be available for engine operation. The power source provided for the engine's control system can also be used to operate auxiliary panels.

Stoichiometric engines have a pin available on the magneto that can be used to provide power for auxiliary panels. This pin provides 180 VDC with a maximum current draw of 20mA. As with the low emission engine, spark plug life will be decreased if the magneto is used to power auxiliary panels.

For all engines with Caterpillar EIS, a 24 VDC power source is necessary.

Spark Plugs

Spark plugs for Caterpillar Gas Engines have been specifically developed to meet the ignition needs of a given engine. Failure to use proper spark plugs, or failure to properly maintain the park plugs will affect the engine's fuel consumption, emissions, and stability. This is why the spark plugs must be maintained according to the specified maintenance schedule. Good maintenance practices can be found in Systems Operation Testing and Adjusting Manual for your engine.

Note: The maximum ambient air temperature for magneto operation is 85°C (185°F).

Attachment 8

Proposed Replacement
Engine Driven Pump No. 5

G3608LE Technical Data

G3608LE Emissions
G3608LE Performance Data
G3600 Product Description and Specifications
G3600 Technical Data
G3600 Engine Basics
G3600 Ignition Systems

Alexander Orr, Jr.
Water Treatment Plant

CATERPILLAR

Caterpillar Inc.
Lafayette Engine Center
Lafayette, Indiana 47905

June 15, 2000

Gas Engine Emissions Letter

Project:	MDWASD Alexander WTP			
Model:	G3608 LE	Rating (note below):	2225	bhp @ 1000 rpm
Compression Ratio:	9.1	BSFC (Btu/bhp-hr):	6810	+/- 3.0%
A/C Inlet Temp. (°F):	130	J/W Outlet Temp. (°F):	190	
Fuel LHV (Btu/ft3):	963	Altitude (ft):	sea level	
Fuel MN:	72.7	Ambient (°F):	110	

	NOx (as NO2)	CO	THC	NMHC	NMNEHC
g/bhp-hr	0.70	2.50	6.00	1.06	0.51
tons/year	15.0	53.7	128.9	22.8	11.0

Exhaust Mass Flow (lbs/hr, wet):	26,548
Exhaust Volume Flow (cfm, wet): @ 842°F stack temp, 14.5 psia	14,816

Emission levels are based on engine operation at steady state conditions adjusted to the specified NOx level. The CO, THC, NMHC, and NMNEHC values listed are higher than nominal levels to allow for instrumentation, measurement, and engine-to-engine variations. They indicate "not to exceed" values. Tons per year values are based on 8,760 hours of operation per year.

This information is valid for engine orders placed within six (6) months of the above date. Please contact the factory after six months if an extension is required.

Sincerely,

Jeffery A. Elijah
G3600 Applications
Lafayette Engine Center

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G3608 SITA 9:1 Industrial Performance

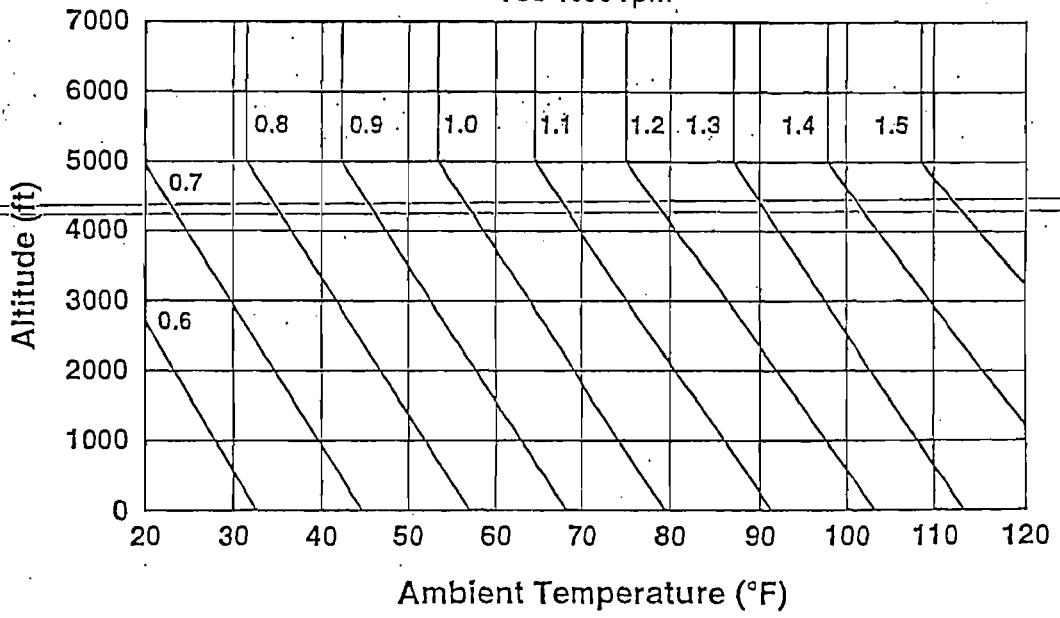
piration			100%	75%	50%	25%
		TA	TA	TA	TA	TA
Speed	rpm	1000	1000	1000	1000	1000
JW Outlet Temperature (°F)		190	190	190	190	190
A/C Inlet Temperature (°F)		130	130	130	130	130
Engine Power	bhp[1]	2225	1669	1113	556	
NOx (as NO_2)	g/bhp-hr[2]	0.70	0.70	0.70	1.20	
CO	g/bhp-hr[2]	1.90	1.90	1.90	2.20	
HC (Total)	g/bhp-hr[2]	5.95	6.30	6.50	6.00	
HC (Non-Methane)	g/bhp-hr[2]	0.89	0.95	0.98	0.90	
Exhaust Oxygen	% (dry)	12.3	11.7	10.7	10.2	
BSFC	Btu/hp-hr	6810	7035	7550	9620	
Compressor Out Pressure	in Hg abs	70.4	54.2	38.6	32.0	
Compressor Out Temp (°F)		290	238	154	132	
Intake Manifold Pressure	in Hg abs	69.7	53.8	38.3	23.9	
Intake Manifold Temp (°F)		148	143	140	136	
Air-Fuel Ratio	vol/vol	20.09	19.93	18.57	17.40	
Timing	°BTDC	20.2	20.2	19	16.2	
Fuel Energy	Btu/min[3]	252538	195661	139990	89185	
F ust (LHV)	Btu/min[4]	97042	76771	56282	34002	
aust (to 350°F)	Btu/min[4]	58201	46698	34427	22433	
Aftercooler	Btu/min[5]	16141	8285	1113	63	
Radiation - Engine only	Btu/min[6]	11177	10468	9659	8740	
Oil Cooler	Btu/min[7]	10325	10025	9750	9450	
Jacket Water	Btu/min[4]	23467	19324	15993	13334	
Air Flow	lb/hr	25760	19794	13195	7876	
Air Flow (scfm @ 77°F, 13.9 psia)		6136	4715	3143	1876	
Exhaust Flow	lb/hr	26537	20396	13626	8150	
Exh Flow (cfm @ stack T, 14.5 psia)		14867	11610	8048	4978	
Exhaust Stack Temp (°F)		847	868	918	965	
Fuel Flow (scfh 4 @ 60°F, 14.7 psia)		16743	12972	9281	5913	

1) Continuous output and reference conditions according to ISO 3046/1 (77°F, 14.5 psia), Natural gas LHV = 905 Btu/sft^3.
(Engine power conversion: 1 bhp = 42.42 Btu/min)
2) Emissions data shown are not to exceed values.
3) Tolerance +/-2.5%
4) Tolerance +/- 10%, jacket water heat rejection based on treated water as coolant
5) Tolerance +/- 5%, heat rejection based on treated water as coolant
6 erance +/- 25%
7 lerance +/- 20%, heat rejection based on treated water as coolant

Aftercooler Heat Rejection Factors

G3608 Industrial – 90°F SCAC

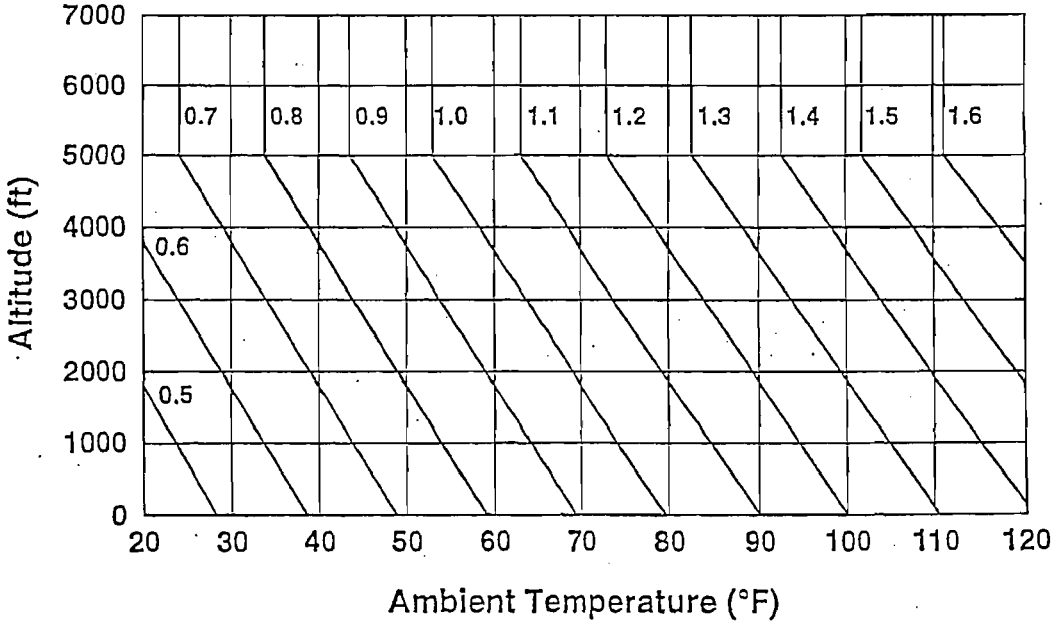
730-1000 rpm



Aftercooler Heat Rejection Factors

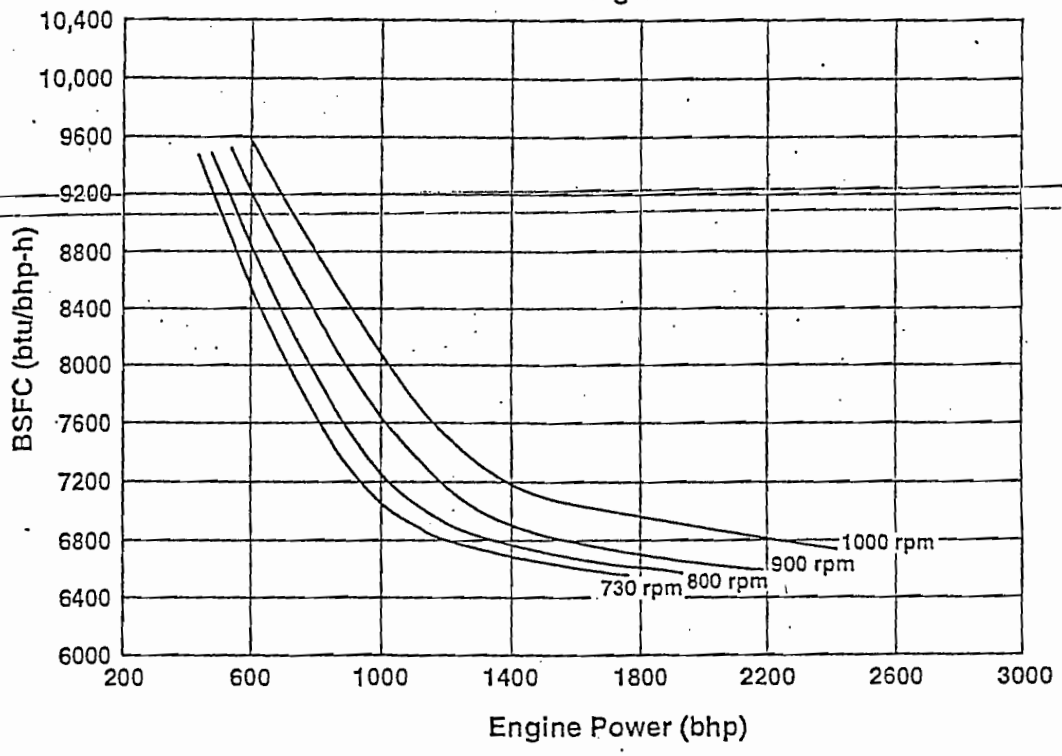
G3608 Industrial – 130°F SCAC

730-1000 rpm



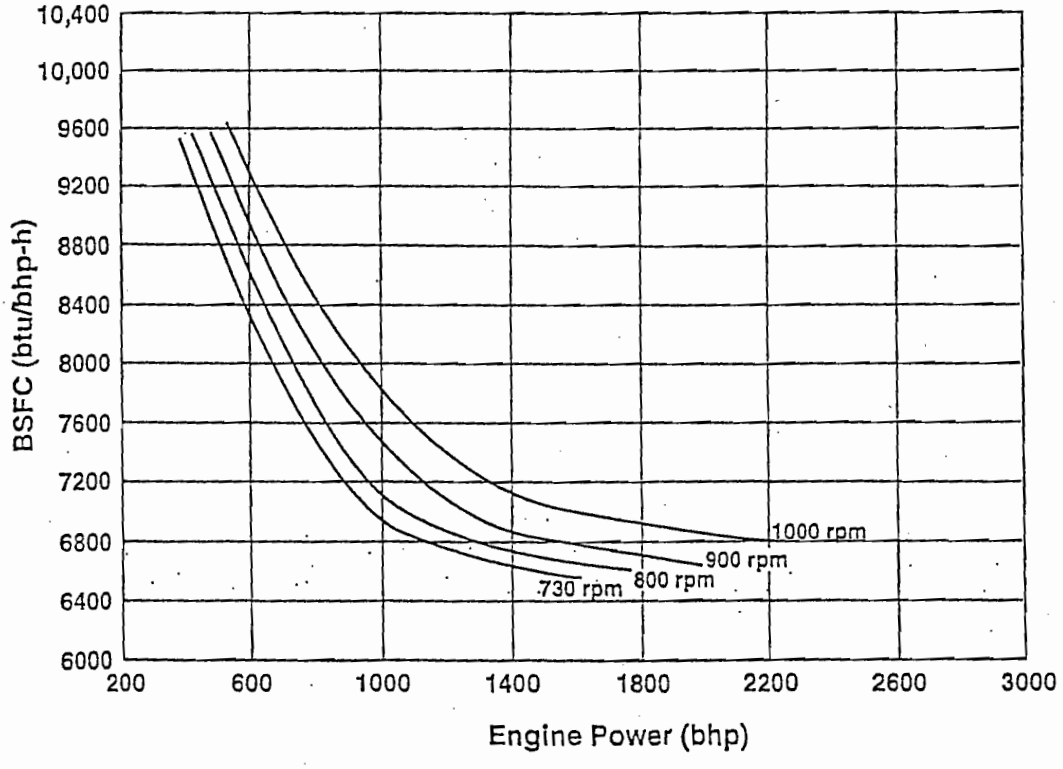
G3608 BSFC

Industrial Turbocharger 90°F SCAC



G3608 BSFC

Industrial Turbocharger 130°F SCAC



CATERPILLAR®

Gas Engine Industrial Low Emission

G3608

1555-2350 HP

FEATURES

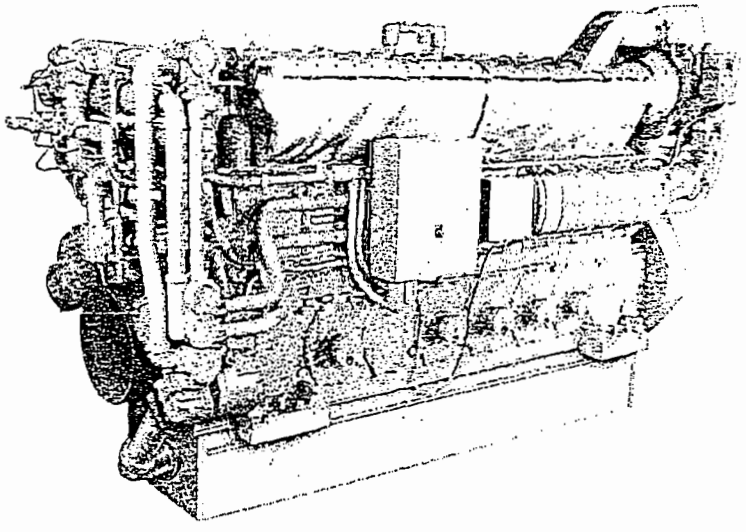
• CATERPILLAR® QUALITY THROUGHOUT
Cat gas engines incorporate many of the same proven components as their diesel counterparts – including the block, crankshaft, main bearings, camshaft and connecting rods. However, by operating at 40 to 50% lower cylinder pressure and bearing loads than diesels, they offer the extra benefit of prolonged life. Caterpillar gas engines inherit more from their diesel counterparts than just strength. They are backed by the same support system recognized as one of the most sophisticated and dependable in the world.

• APPLICATION FLEXIBILITY
Broad operating speed range and the ability to burn a wide spectrum of fuels.

• LOW EMISSIONS
1gram/hp hr NOx level at 1000 RPM.

• SUPERIOR TECHNOLOGY
Represent the latest technology in engine design. The engine is offered in a low emission turbocharged and aftercooled configuration only. This configuration offers:
- High energy ignition systems for consistent firing
- Highly efficient enriched prechamber design for complete combustion
- Modern component design such as deep cup, oil gallery piston
- Electronic controls to optimize performance.

• RESULT
Low emissions and BSFC under all operating conditions.



Arrangement may be shown with optional equipment

STANDARD PACKAGE ARRANGEMENT

GENERAL
Flywheel and Ring Gear
Crankcase Explosion Doors
High Efficiency Turbos
Aftercooler
Engine Barring Device
Torsional Vibration Damper
Industrial Engine Supports
Protective Guards

COOLING SYSTEM
Jacket Water Pump
Water Regulators, 189° F
Separate Circuit Gear Driven Pump For Aftercooler/Oil Cooler Circuit

IGNITION SYSTEM
Altronic III Ignition with Variable Timing

CONTROLS
Electronic Supervisory System:
- Governing
- Air/Fuel Ratio Control
- Timing Optimization

Instrument Panel to Monitor:
- Oil Pressure and Temperature
- Oil Pressure Differential
- Intake Manifold Pressure
- Intake Manifold Temperature
- Crankcase Pressure
- Water Temperatures
- Exhaust Temperatures
- Service Meter Hours
- Engine Speed

FUEL SYSTEM
Fuel Filter
Shipped Loose Gas Pressure Regulator

PROTECTION
Misfire Sensing
Detonation Sensing and Compensation

Energized to Run Shutdowns for:
- Engine Overspeed
- Oil Pressure
- Water Pressure
- Crankcase Pressure

LUBE OIL SYSTEM
Gear Driven Lube Oil Pump
Engine Mounted Lube Oil Filters
Engine Mounted Lube Oil Cooler
Prelube/Postlube System
Sump Pump Connections

AIR INTAKE SYSTEM
Shipped Loose Air Cleaners
Installed Turbo Air Inlet Adapters

ATTACHMENTS
Custom Industrial Base
Expansion Tank

G3608 INDUSTRIAL GAS ENGINE GENERAL SPECIFICATIONS

Continuous Ratings (BHP)

	1000 rpm	900 rpm	800 rpm	700 rpm
LE TA-90	2350	2120	1880	1645
LE TA-130	2225	2000	1775	1555

Physical Factors

	Height	Width	Length	Weight
LE TA	129.2 in	64.7 in	213.5 in	48,800 lbs

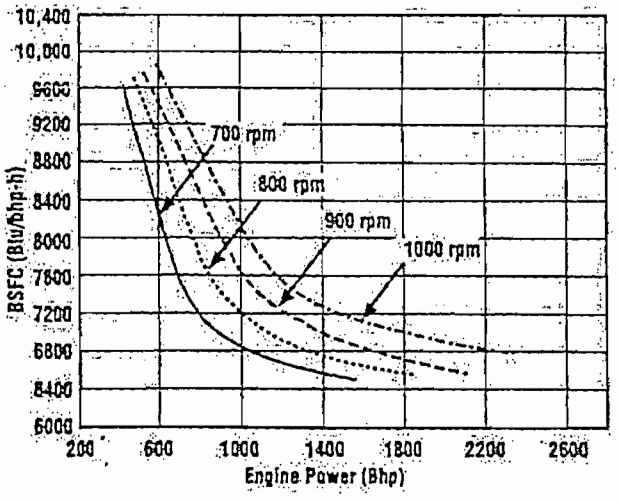
General Specifications

CAT 3608 ENGINE

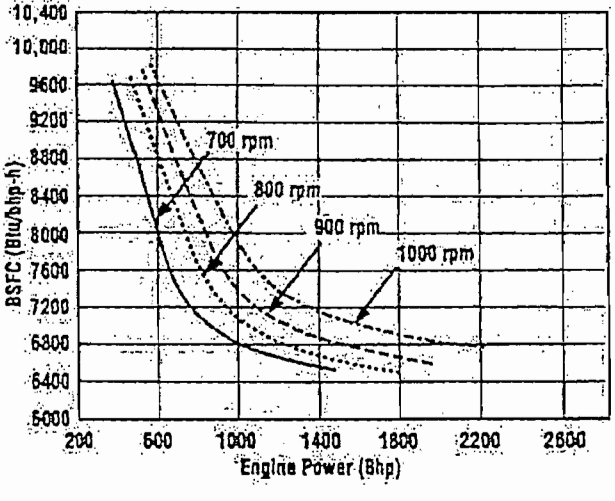
Type — Spark Ignited
Displacement — 10,350 cu in
Compression Ratio — 9.2:1
Lube oil capacity — 341 gal
Jacket water system — 140 gal

No. of Cylinders — 8
Bore — 300 mm
Stroke — 300 mm

90°F SCAC

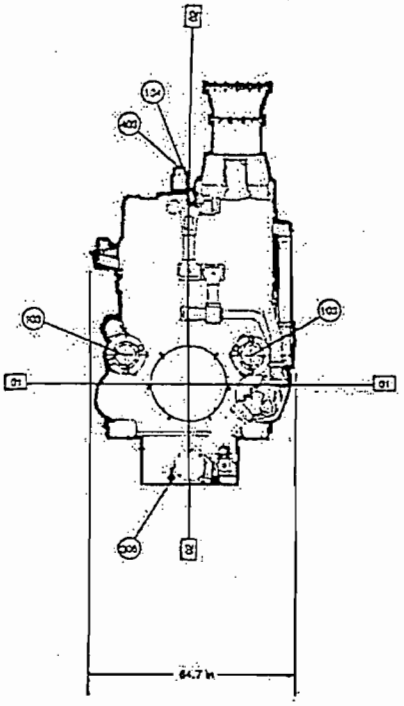


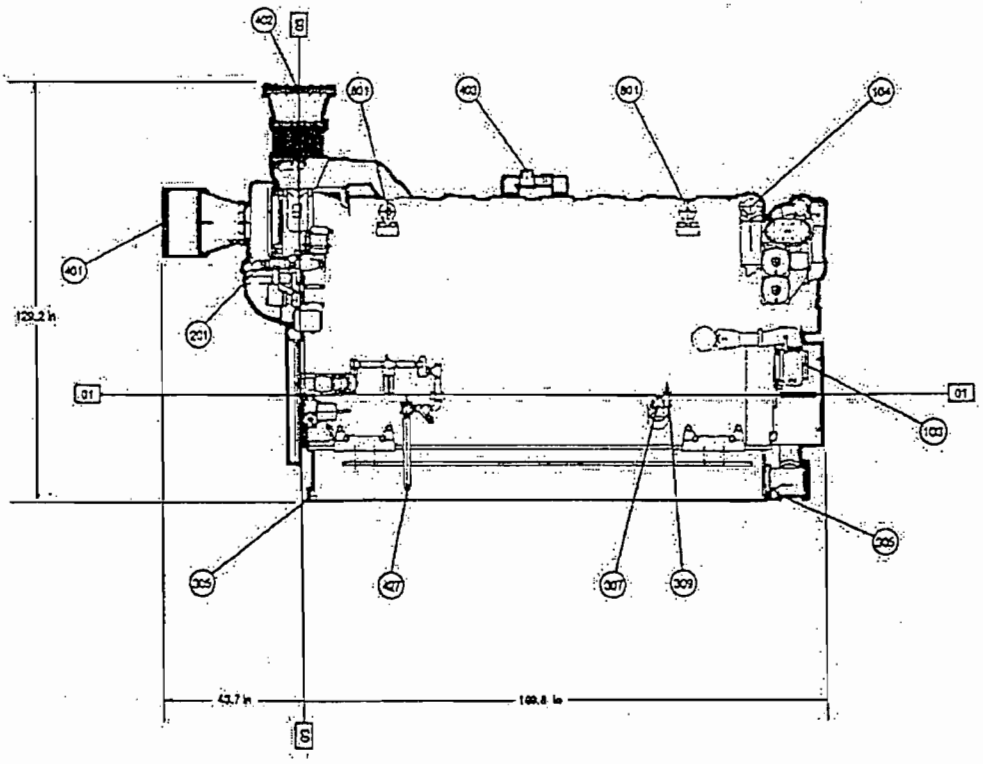
130°F SCAC



G3608 INDUSTRIAL GAS ENGINE CONFIGURATION

- 01 - CENTERLINE OF CRANKSHAFT
- 02 - CENTERLINE OF ENGINE
- 03 - REAR FACE OF CYL BLOCK
- 103 WATER INLET
- 104 WATER OUTLET
- 201 FUEL INLET
- 305 OIL DRAIN
- 307 OIL FILLER
- 309 OIL LEVEL GAUGE
- 401 AIR INLET
- 402 EXHAUST
- 403 BREATHER OUTLET
- 427 AIR STARTING MOTOR INLET
- 801 LIFTING EYE





Note: General Configuration not to be used for installation.

CONDITIONS & DEFINITIONS

Ratings are based on SAE J1349 standard conditions of 100 kPa (28.61 in)Hg and 25°C (77°F). ISO 3046, DIN 6271, BS 5514 standard conditions of 100 kPa (29.61 in)Hg, 27°C (81°F); and API 7B-11C standard conditions of 99 kPa (29.38 in)Hg, 29°C (65°F) also apply.

Ratings are based on dry natural gas having a low heat value of 35.22 MJ/m³ (905 btu/ft³). Variations in altitude, temperature and gas composition from standard conditions may require a reduction in engine horsepower.

Turbocharged-aftercooled ratings apply to 1525 m (5,000 ft) and 25°C (77°F). For applications which exceed these limits contact your Caterpillar Dealer.

Materials and specifications are subject to change without notice. The International System of Units (SI) is used in this publication.

CATERPILLAR®

LEHH3119

Printed in U.S.A.

CATERPILLAR®

G3600 Engine Basics

4/99

Engine Design Specifications

G3606

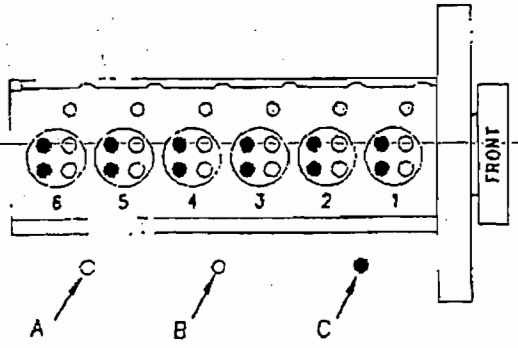


Illustration 1
G3606 Engine Design
(A) Inlet. (B) Gas admission. (C) Exhaust.

Number and arrangement of cylinders .....In-line 6

Valves per cylinder

Inlet valves 2
Exhaust valves 2
Gas inlet valve 1

Displacement .....127.2 L (7762 cu in.)

Bore .....300 mm (11.8 in.)

Stroke .....300 mm (11.8 in.)

Compression ratio 9.2:1

Combustion .....Spark Ignited

Firing order

Standard rotation CCW 1-5-3-6-2-4

Valve lash

Inlet .....0.50 mm (.020 in.)
Exhaust .....1.27 mm (.050 in.)
Gas admission .....0.64 mm (.025 in.)

When the crankshaft is viewed from the flywheel end the crankshaft rotates in the following direction . .....Counterclockwise

Note: The front end of the engine is opposite the flywheel end of the engine. The left and the right side of the engine are determined from the flywheel end. The number 1 cylinder is the front cylinder.

G3608

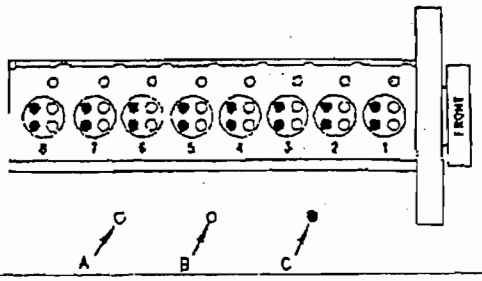


Illustration 2
G3608 Engine Design
(A) Inlet. (B) Gas admission. (C) Exhaust.

Number and arrangement of cylinders .....In-line 8

Valves per cylinder

Inlet valves 2
Exhaust valves 2
Gas admission valve 1

Displacement .....170 L (10,352 cu in.)

Bore .....300 mm (11.8 in.)

Stroke .....300 mm (11.8 in.)

Compression ratio 9.2:1

Combustion .....Spark Ignited

Firing order

Standard rotation CCW 1-6-2-5-8-3-7-4

Valve lash

Inlet .....0.50 mm (.020 in.)
Exhaust .....1.27 mm (.050 in.)
Gas admission .....0.64 mm (.025 in.)

When the crankshaft is viewed from the flywheel end the crankshaft rotates in the following direction . .....Counterclockwise

Note: The front end of the engine is opposite the flywheel end of the engine. The left and the right side of the engine are determined from the flywheel end. The number 1 cylinder is the front cylinder.

G3612

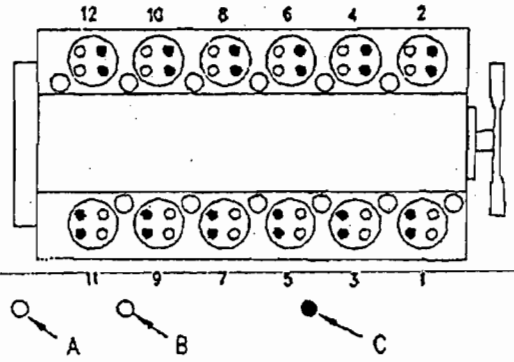


Illustration 3
G3612 Engine Design
(A) Inlet. (B) Gas admission. (C) Exhaust.

Number and arrangement of cylinders .....Vee 12

Valves per cylinder

Inlet valves 2
Exhaust valves 2
Gas admission valve 1

Displacement .....254.5 L (15,525 cu in.)

Bore .....300 mm (11.8 in.)

Stroke .....300 mm (11.8 in.)

Compression ratio 9.2:1

Compression ratio 10.5:1

Combustion .....Spark Ignited

Firing order

Standard rotation
CCW 1- 12-9-4-5-8-11-2-3-10-7-6

Valve lash

Inlet .....0.50 mm (.020 in.)
Exhaust .....1.27 mm (.050 in.)
Gas admission .....0.64 mm (.025 in.)

When the crankshaft is viewed from the flywheel end the crankshaft rotates in the following direction . .....Counterclockwise

Note: The front end of the engine is opposite the flywheel end of the engine. The left and the right side of the engine are determined from the flywheel end. The number 1 cylinder is the front cylinder.

G3616

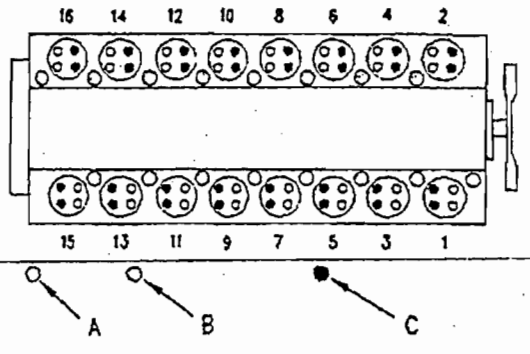


Illustration 4
G3616 Engine Design
(A) Inlet. (B) Gas admission. (C) Exhaust.

Number and arrangement of cylinders .....Vee 16

Valves per cylinder

Inlet valves 2
Exhaust valves 2
Gas admission valve 1

Displacement .....339.3 L (20,700 cu in.)

Bore .....300 mm (11.8 in.)

Stroke .....300 mm (11.8 in.)

Compression ratio 9.2:1

Compression ratio 10.5:1

Combustion .....Spark Ignited

Firing order

Standard rotation CCW
..... 1-2-5-6-3-4-9-10-15-16-11-12-13-14-7-8

Valve lash

Inlet .....0.50 mm (.020 inch)
Exhaust .....1.27 mm (.050 inch)
Gas admission .....0.64 mm (.025 inch)

When the crankshaft is viewed from the flywheel end the crankshaft rotates in the following direction . .....Counterclockwise

Note: The front end of the engine is opposite the flywheel end of the engine. The left and the right side of the engine are determined from the flywheel end. The number 1 cylinder is the front cylinder.

Engine Supervisory System

The Engine Supervisory System (ESS) is specifically designed for the Caterpillar G3600 Engines. The ESS integrates several control systems that are installed on the engine. With the ability to communicate with the various systems, the ESS optimizes each controlled parameter in order to ensure maximum engine performance.

The ESS communicates with the following systems:

- Start/Stop/Prelube Logic
- Engine Monitoring And Protection
- Governing
- Air/Fuel Ratio
- Ignition Control

The control panel for the ESS is the center of control for the systems. The control panel for the ESS contains the control modules of each system.

The Engine Supervisory System consists of the following components:

- Control Panel For The Engine Supervisory System (ESS)
- Engine Mounted Junction Box
- Engine Mounted Sensors And Actuators
- Relays, Solenoids And Switches
- Harness

The Engine Supervisory System (ESS) is divided into the following three interactive systems:

Start/Stop/Prelube System – This system controls the starting of the engine, the stopping of the engine, and the prelube pump.

Engine Monitoring And Protection System – This system provides a display of parameters of engine operation. The system generates warnings when one or more parameters are outside acceptable limits. The system can stop the engine if the engine operation reaches a setpoint that is programmed for shutdown. The system can prevent the engine from starting if certain parameters are outside of acceptable limits.

Engine Control System – This system governs the engine. This system controls the air/fuel ratio, the ignition timing, and the limiting of power.

Note: Some of the components within the ESS perform more than one function. For example, the Engine Control Module (ECM) is involved with starting the engine, stopping the engine, monitoring the engine, and controlling the engine.

Engine Mounted Sensors

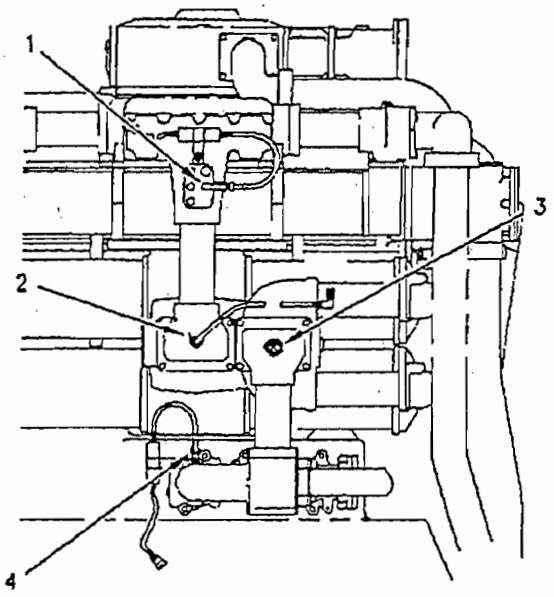


Illustration 5
Engine Mounted Sensors Front View
(1) CMS unfiltered engine oil pressure sensor. (2) SCM engine oil temperature sensor. (3) SCM filtered engine oil pressure sensor. (4) CMS filtered engine oil pressure sensor.

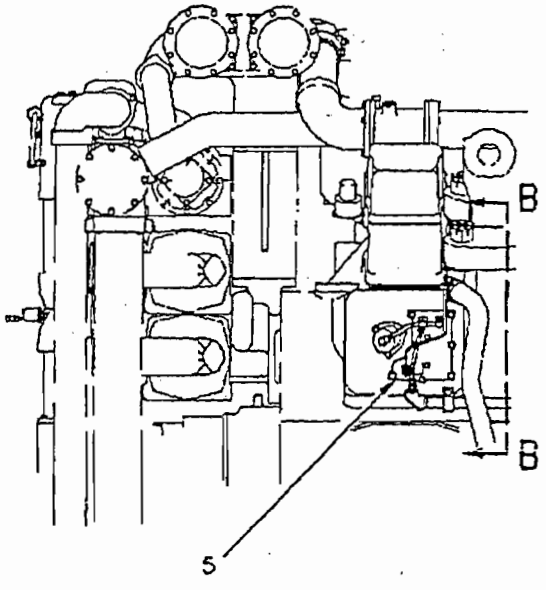


Illustration 6
Engine Mounted Sensors Left Side View
(5) Combustion buffer.

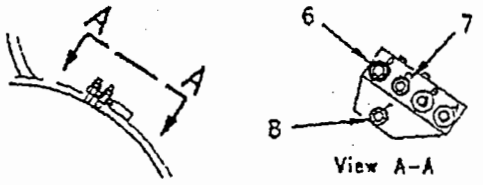


Illustration 7
Engine Mounted Sensors Rear View
(6) Timing control speed sensor. (7) Engine control speed sensor. (8) Timing control crank angle sensor.

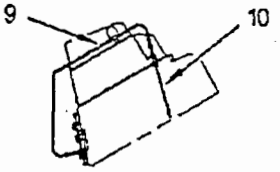


Illustration 8
Engine Mounted Sensors View B-B
(9) Combustion feedback cable. (10) Combustion feedback extension and probe.

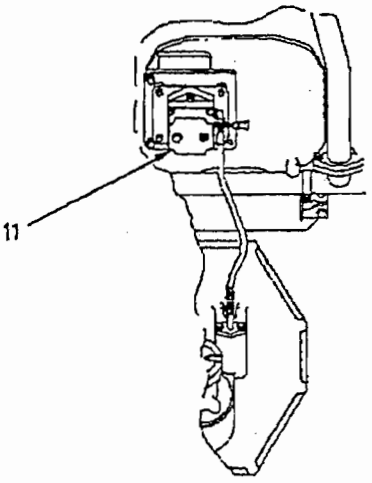


Illustration 9
Engine Mounted Sensors Right Side View
(11) Crankcase pressure sensor.

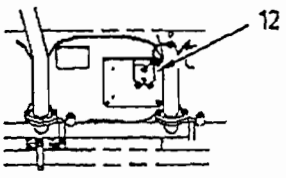


Illustration 10
Detonation Sensors
(12) Detonation sensors.

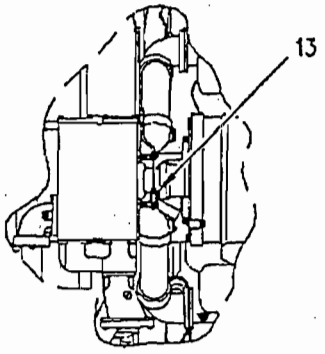


Illustration 11
Engine Mounted Sensors Top View
(13) Jacket water temperature sensor.

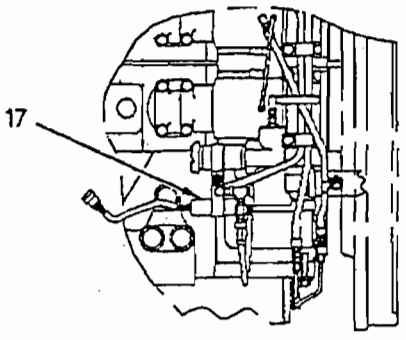


Illustration 14
Engine Mounted Sensors Left Side View
(17) Starting air pressure sensor.

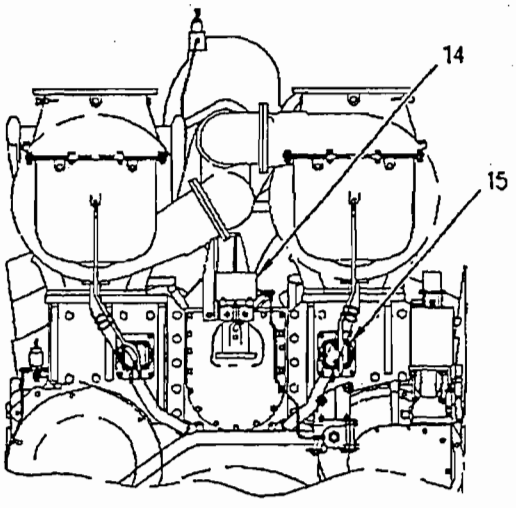


Illustration 12
Engine Mounted Sensors Rear View
(14) Fuel and air Pressure module. (15) Inlet air restriction.

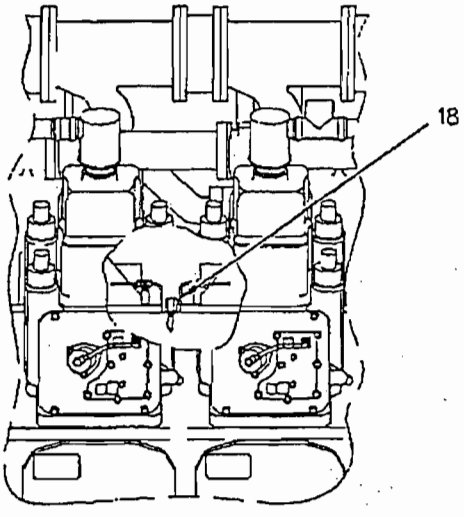


Illustration 15
Engine Mounted Sensors Right Side View
(18) Inlet air temperature sensor.

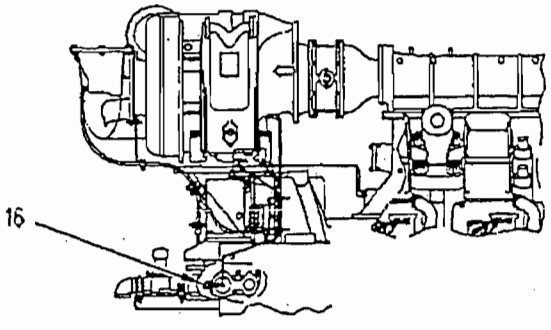


Illustration 13
Engine Mounted Sensors Right Side View
(16) Fuel temperature sensor.

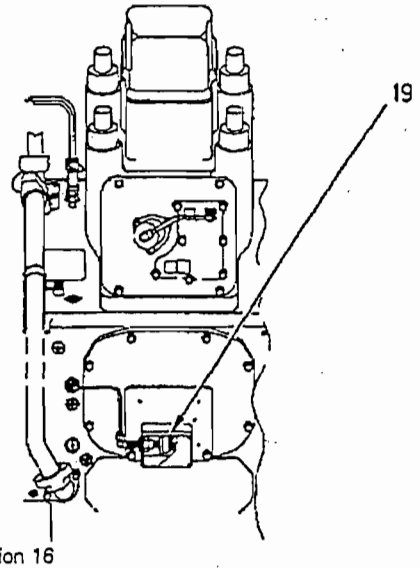


Illustration 16
Engine Mounted Sensors Right Side View
(19) Prelube pressure switch.

Control Panel For The Engine Supervisory System (ESS)

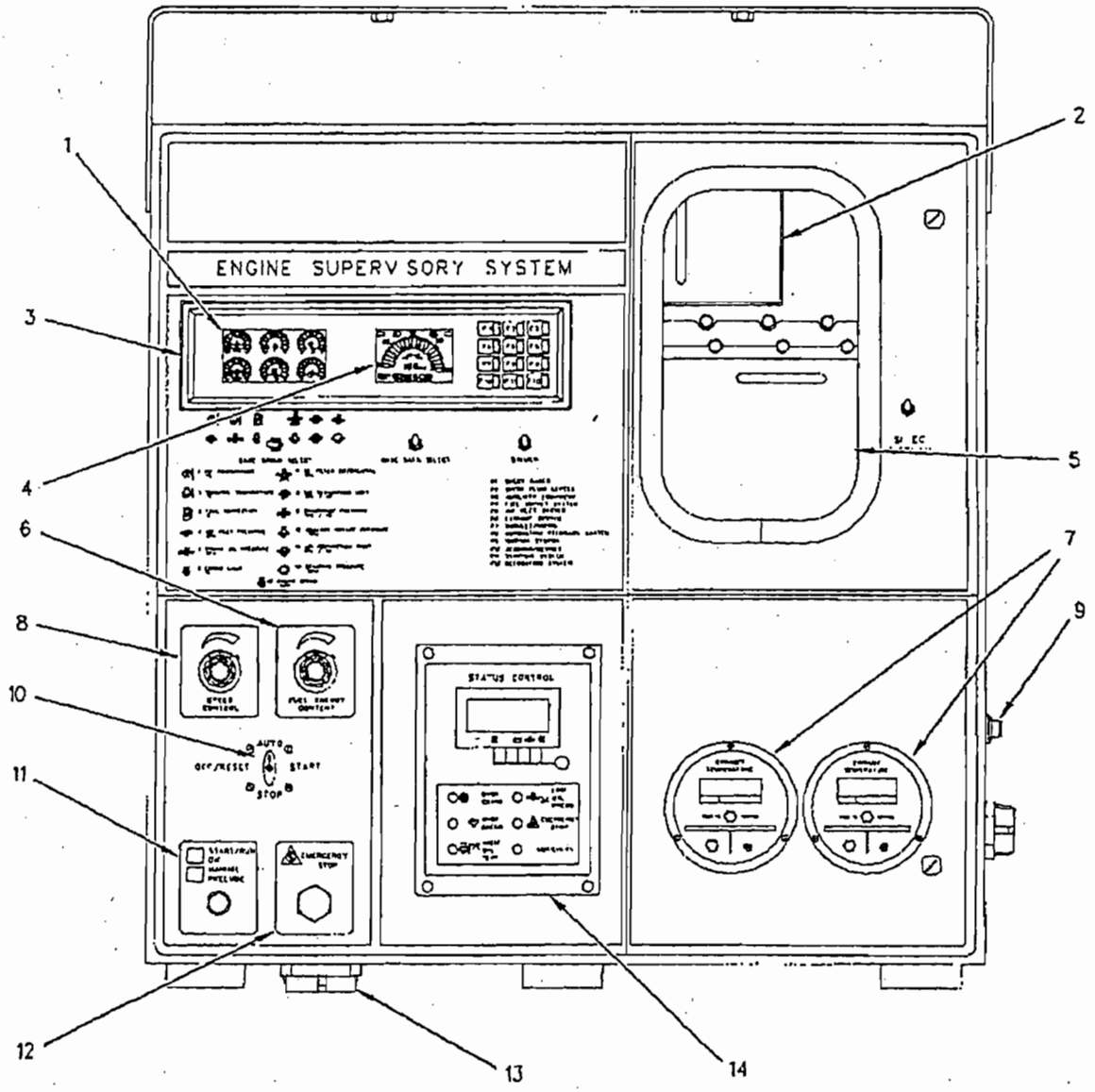


Illustration 17
(1) LED Dial gauges. (2) Timing Control Module (TCM). (3) CMS Gauge panel. (4) Digital gauge readout. (5) Engine Control Module (ECM). (6) Fuel energy adjustment dial. (7) Exhaust pyrometer. (8) Engine speed adjustment dial. (9) Digital Diagnostic Tool (DDT) connection. (10) Mode control switch. (11) Prelube switch. (12) Emergency stop push button. (13) Sensor wiring to the engine. (14) Status Control Module (SCM).

This panel contains the control modules, the switches, and the potentiometers that are associated with the system.

- Engine Control Module (ECM) (System Coordination, Governing, Air/Fuel Ratio Control)
- Timing Control Module (TCM) (Ignition System Control)
- Status Control Module (SCM) (Start/Stop Control)
- Computerized Monitoring System (CMS) (Gauge Panel Display of System Parameters)
- Pyrometer Module (Display of Exhaust Temperatures)
- Mode Control Switch (MCS)
- Prelube Switch/Start Run Okay Lamp
- Emergency Stop Switch
- Fuel Energy Adjustment Potentiometer
- Desired Speed Adjustment Potentiometer
- Gauge Group Select Switch
- Gauge Data Select Switch
- Display Select Switch
- Dimmer Switch Diagnostics

Diagnostics

The Engine Supervisory System is self-diagnostic. Through lights and fault codes, the ESS directs the service technician to the system or the component that requires maintenance.

Mounting

The control panel for the ESS is a waterproof enclosure. The control panel is intended to be mounted at a remote location. The control panel can be mounted up to 30.5 m (100 ft) from the engine.

Hazardous Environments

The engine and the Engine Supervisory System have been Canadian Standards Association (CSA) certified for use in hazardous locations Class 1, Division 2, Group D.

Customer Interface Connections

Refer to Installation And Initial Start-up Procedures, SEHS9549, for information regarding customer input and output connection points.

RS232 Computer Interface

RS232 output of system data is available for customer monitoring and information systems. This output requires a ship loose converter module.

Start/Stop/Prelube System

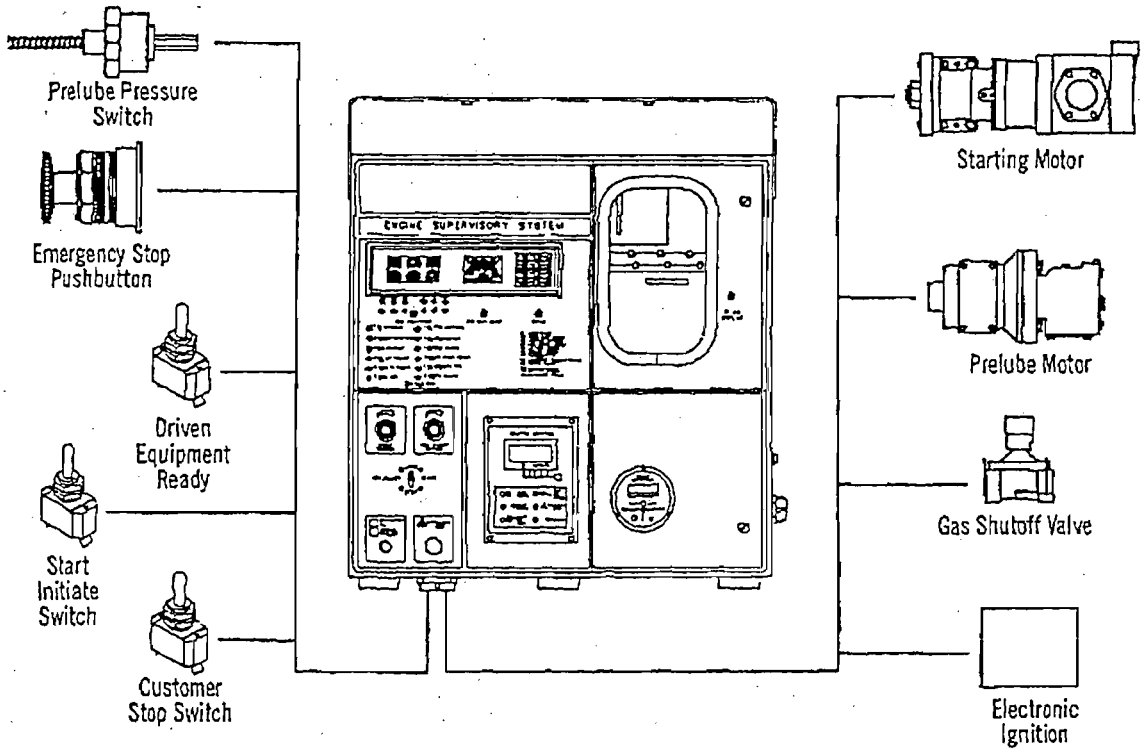


Illustration 18

The system consists of the following components:

1. The Control Panel For The Engine Supervisory System (ESS). The control panel consists of the following components:
   - Mode Control Switch (MCS)
   - Status Control Module (SCM)
   - Engine Control Module (ECM)
   - Prelube Switch/Lamp
   - Speed Control Dial
   - Fuel Energy Content Dial
   - Emergency Stop Push Button
2. Gas Shutoff Valve (GSOV)
3. Ignition System
4. Fuel Actuator
5. Prelube Pump System (Pump And Solenoid)
6. Engine Cranking System (Starting Motors And Solenoids)

The controls for the Start/Stop/Prelube and the Status Control Module perform the automatic start/ stop functions. The Status Control Module monitors certain engine functions that are required for operation. The Status Control Module monitors and provides an automatic shutdown of the engine under normal operating conditions.

The Speed Control Potentiometer will allow the operator the ability to select the engine speed that is needed for a particular application. Low idle speed is 550 rpm. Rated speed can be as high as 1000 rpm.

The Fuel Energy Content Potentiometer is used in order to adjust the setting for the Lower Heat Value of the fuel. The Fuel Energy Content Potentiometer setting should be adjusted in order to display a Btu value on the ECM that is equal to the Lower Heating Value of the fuel supply in terms of Btu/ft^3. The Lower Heating Value Btu is based on the data from a fuel analysis that is input into the Caterpillar Methane Number Program, 5.0, LEKQ6378-01.

The major functions of this system are controlled by the following components:

- Mode Control Switch (MCS)
- Prelube Push Button

The MCS has the following four positions and operations:

- AUTO
- START
- STOP
- OFF/RESET

AUTO – When the mode control switch is in the AUTO position, the system is configured for remote operation. When the remote start/stop initiate contact closes, the prelube system will operate and the engine will start. When the remote start/stop initiate contact opens, the engine will shut off. If the cool down cycle is programmed, the engine will operate for the cool down period before the engine stops. The cool down cycle can be programmed for a 0 to 30 minute period. A cool down period is not recommended for G3600 engines.

START – When the mode control switch is turned to the START position, the prelube system will operate. When the prelube pressure is sufficient, the engine will start. The engine will operate until the ESS receives a shut down signal.

STOP – When the mode control switch is turned to the STOP position, the engine will shut off. After the engine stops, a postlube cycle will operate. The power to the control panel is maintained when the mode control switch is in the STOP position. The "STOP" mode can be used to troubleshoot some problems without starting the engine.

OFF/RESET – When the mode control switch is turned to the OFF/RESET position, the engine is immediately shut off and the diagnostic lights of the status control module are reset. Power is removed from the control panel and the actuators after the engine completes the postlube cycle.

MANUAL PRELUBE button enables the operator to prelube the engine. All G3600 Family Engines should be lubricated before the crankshaft is rotated. This includes crankshaft rotation in order to service the engine. Rotating the crankshaft before prelube may cause damage to the crankshaft bearings if the surfaces of the bearings are dry.

All G3600 Family Engines require lubrication prior to start-up. The ESS will not permit the engine to start until sufficient prelube pressure has been achieved. The actuators will be powered up after the engine has been prelubed.

Note: The ECM is programmed to provide engine lubrication after the engine is shut off. The typical duration of the postlube is 60 seconds.

The EMERGENCY STOP push button immediately de-energizes the Gas Shutoff Valve and grounds the CIS in order to stop the engine (no cool down). The engine may not be restarted until the Status Control Module has been reset by turning the MCS to the OFF/RESET position. More than one EMERGENCY STOP push button may be used, depending on the engine installation.

NOTICE

The EMERGENCY STOP push button is not to be used for normal engine shutdown. To avoid possible engine damage, use the Mode Control Switch (or Start Initiate Contact for remote operation) for normal engine shutdown.

These engines require a prelube cycle prior to start-up. The engine will not start until the Status Control Module tells the Engine Supervisory System that the minimum requirement for oil lubrication has been reached.

The Engine Control Module is programmed to provide a period of engine lubrication (postlube) after shutdown. The time that is required for postlube is typically 60 seconds.

Sequence Of Operation

The Mode Control Switch (MCS) of the remote control panel has four positions: AUTO, START, STOP, OFF/RESET. If the MCS is in the AUTO position and a signal to run is received from a remote initiate contact (IC), or when the MCS is placed in the START position, the engine will prelube, crank, terminate cranking and run. The engine may cycle crank if the feature for cycle crank is utilized. The engine will run until the signal to run is removed by either turning the Mode Control Switch (MCS) to STOP, OFF/RESET, or opening the remote initiate contact with the MCS in the AUTO position. Once the MCS is moved to the STOP position, or if in the AUTO position and the remote initiate contact opens, the engine will run for a short period of time in the cool down mode, if the cool down feature was utilized, If the cool down feature was not utilized the engine will shut down immediately. The engine will then start the postlube cycle. The engine is then capable of immediate restart.

Sequence Of Operation (Normal Start/ Stop)

When the MCS is placed in the START position or the AUTO position and the remote initiate contact is closed:

1. A signal is sent to the prelube relay.
2. The prelube pump will run.
3. The prelube switch will close to indicate that 6.9 kPa (1 psi) of oil pressure is at the switch.
4. After a preprogrammed period of time (typically 30 seconds), the ECM will send a signal in order to energize the prelube pump switch relay The green prelube light will turn on. CMS Gauge No. 5 will stop flashing. A start signal is sent to the SCM.

Upon receipt of a signal to start, the SCM will check in order to ensure that the following conditions are met:

1. An emergency stop signal is not present.
2. All faults have been reset.
3. All sensors are connected and operating properly.
4. No abnormal mode control switch signals are present.
5. The engine is not already running.
6. The SCM microprocessor is functioning properly.
7. The SCM is not in the programming mode.

The SCM will not allow the start sequence to begin. The SCM will display the proper diagnostic code when applicable, if an above fault condition exists. However, once the SCM is satisfied that conditions are normal, the SCM will energize the Starting Motor Relay (SMR) and the Run Relay (RR). The SCM will also signal for fuel to be turned on by energizing the Fuel Control Relay (FCR) and the Run Relay (RR). The fuel actuator will begin to open at 50 rpm. The Ignition Shutoff Relay will be energized in order to begin the ignition system functioning.

If the feature for cycle crank is enabled, the SCM will automatically crank/rest/crank the engine for adjustable time periods. If the engine fails to start within the selected total crank time, the SCM will execute an overcrank fault. If a fault condition occurs while the engine is cranking, the SCM will terminate and lock out cranking. The SCM will display the applicable diagnostic code, or the SCM will light the appropriate LED.

After the engine starts and has achieved the crank termination speed (typically 250 rpm), the SCM will de-energize the starting motor by de-energizing the SMR. The SCM will energize the Crank Termination Relay (CTR). Once the correct low idle oil pressure is achieved, the SCM will signal for the ECM to accelerate the engine to rated speed.

The engine will run if the operating conditions remain normal and a signal to run is being received by the SCM. The SCM will sequentially display each of the following for a two second period: the engine oil pressure, the oil temperature, the rpm, the service hours, and the system DC volts. This is done via the digital display prior to or while the engine is operating. As well as monitor for any fault or abnormal conditions that may occur.

Upon loss of the run signal, the engine will continue to run for an adjustable cool down period if the cool down feature is utilized. However, if the cool down feature is not used or if the SCM receives an off/reset signal, the SCM will immediately de-energize the Run Relay. The fuel circuitry will be de-energized. If the signal to run returns before the engine stops, the SCM will immediately go back to the running state. This means, the fuel will be turned back on, but the starting motor will not energize. However, if a restart does not occur and the rpm continues to drop, then the SCM will initiate cranking upon reaching zero rpm, Assuming that the run signal does not return and the engine speed continues to diminish until zero rpm is reached, then the Crank Termination Relay (CTR) will be de-energized and the SCM will be ready for an instant restart. The Fuel Control Relay will be ready for an instant restart. The Fuel Control Relay (FCR) of the SCM will de-energize in two seconds after zero rpm.

Sequence Of Operation (Fault Conditions)

If a fault condition occurs prior to starting the engine, the SCM will:

1. De-energize and lock out the starting motor circuit.
2. Ensure that fuel is shut off.
3. De-energize the Run Relay Circuit.
4. Energize the fault shutdown circuitry (Engine Failure Relay).

If a fault condition occurs while the engine is running, then the SCM will respond in the following manner:

1. Fuel control circuitry will be de-energized for energized to run engines.
2. Ignition Shutoff Relay will be de-energized, for an overspeed, emergency stop, or diagnostic codes 01, 04, 06 or if all six LEDs are on. The relay will also de-energize if the engine has not shut down within five seconds after the FCR commanded it to do so. This would be the result of a fault condition. The relay circuitry shall be re-energized for 10 to 15 seconds after the engine reaches zero rpm. The relay shuts off the ignition system.
3. The Starting Motor Relay (SMR) circuitry shall be locked in the de-energized state.
4. The Run Relay (RR) circuitry shall be de-energized.
5. The Fault Shutdown Circuitry shall be energized, including the Engine Failure Relay (ENFR).

If a fault occurs before or after the engine starts, then the appropriate fault indicating LED shall flash at two Hertz or a diagnostic code shall be displayed to indicate the nature of the problem. The indicators shall remain on. The SCM shall remain in the fault mode until it receives a reset signal.

Engine Monitoring And Protection System

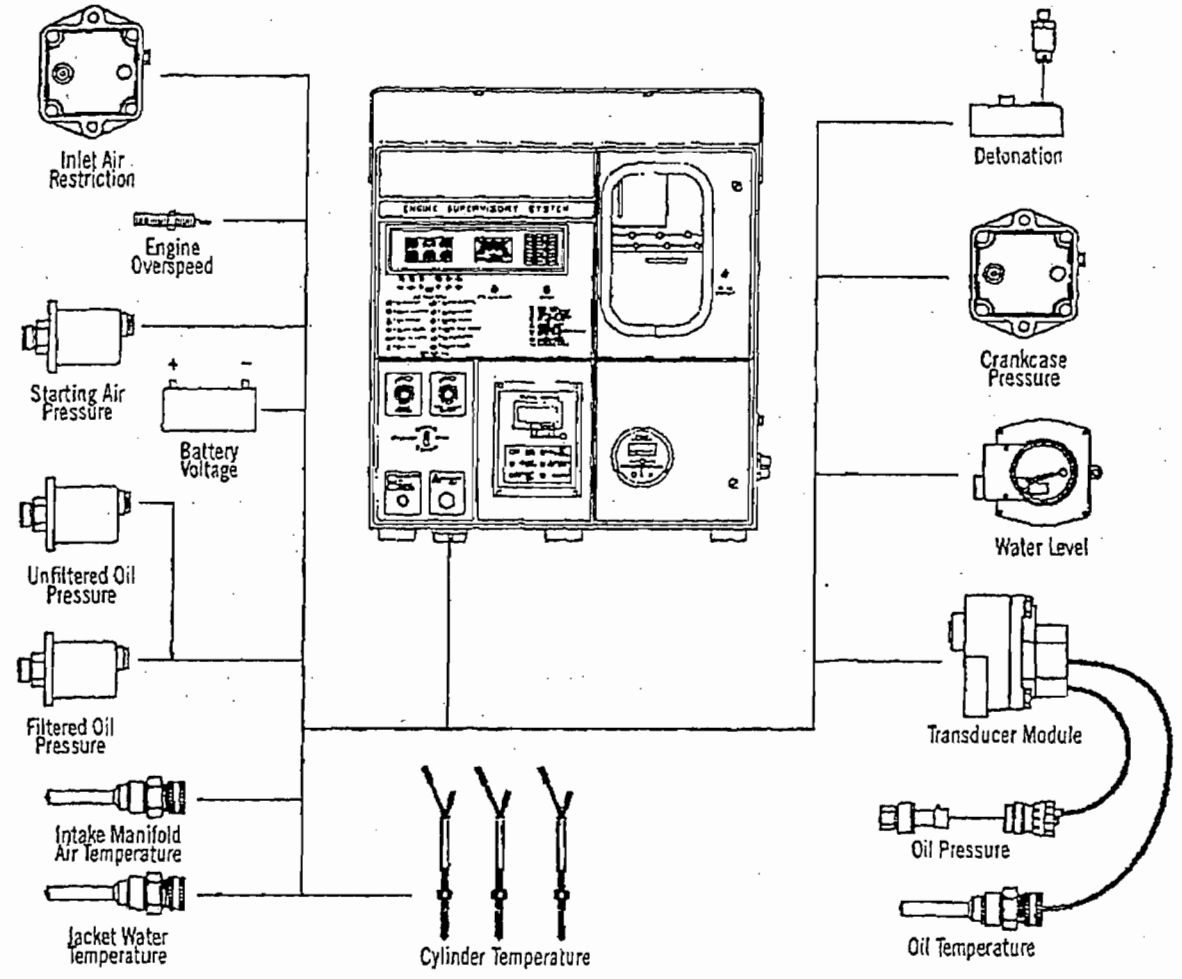


Illustration 19

The system provides engine protection and monitors engine systems for vital parameters. The system provides warnings and/or inhibits the engine from starting. The system shuts down the engine when the parameters are outside acceptable limits. Along with these features, the system provides display/ indication of the engine operating parameters.

Engine Shutdown And Start Inhibiting Functions

The engine shutdown features provide engine protection by shutting down the engine when certain operating parameters are beyond acceptable limits. The engine shutdown features provide engine protection when the driven equipment sense a shutdown signal to the control panel for the ESS.

The start inhibiting features provide protection to the engine and the driven equipment by preventing the engine from cranking when the engine parameters are not

within acceptable limits or the driven equipment has indicated that the driven equipment is not ready to start.

Engine shutdown and start inhibiting problems will be indicated by the CMS panel display, the Engine Control Module (ECM) or the Status Control Module (SCM). The CMS panel display will provide a diagnostic indication when the lights are ON. The ECM will display a FLASHING diagnostic code to indicate that engine shutdown due to a specific problem that was encountered. The ECM will display a SOLID diagnostic code in order to indicate that a warning condition has occurred due to a specific problem that was encountered. For additional information on troubleshooting the displayed information, refer to Troubleshooting, SENR6510, for G3600 Engines.

Computerized Monitoring System (CMS)

The display consists of six small gauges (left side) and one larger gauge (center). The information that is displayed on the gauges is controlled by the GAUGE GROUP SELECT switch and the GAUGE DATA SELECT switch. The GAUGE GROUP SELECT switch selects between two sets of parameters that are available for display on the six small gauges.

The GAUGE GROUP SELECT switch allows the data that is provided on each of the gauges to be viewed on the digital readout. The digital readout is located below the large center gauge. The upper number in the gauge display will indicate which parameter is being viewed. Each time that the GAUGE DATA SELECT switch is toggled, the next gauge is selected. This is within the range of gauges currently selected by the GAUGE GROUP SELECT switch.

If the GAUGE GROUP SELECT switch is switched, then the digital gauge will change to the gauge for the corresponding gauge position, If gauge 2 coolant temperature was selected and the GAUGE GROUP SELECT switch is moved the gauge data will switch to gauge 8, AIR RESTRICTION LEFT.

CMS Gauge Display

The film on the control panel for the ESS is either in English Units or Metric Units. Depending on the application, the readouts will be in either English Units or Metric Units. By setting the "GAUGE GROUP SELECT" switch to the left, the following engine functions are displayed on the gauge and the digital readout.

Gauge 1 AIR TEMPERATURE – The temperature of the air inlet manifold is displayed in °C or °F. The temperature is displayed within one degree.

Gauge 2 COOLANT TEMPERATURE – Temperature is displayed in °C or °F. The temperature is displayed within one degree.

Gauge 3 FUEL CORRECTION – The display shows a percent value. This is a ratio of the difference between the adjusted setting of the fuel energy content Btu potentiometer and the Btu energy content of the fuel that the engine is burning.

Note: When the red limit bars on this gauge are turned off, the air/fuel ratio is not being automatically controlled and the fuel correction factor is fixed at 100%. When the red bars are present, the air/fuel ratio control is based on the in cylinder measured combustion burn time.

Gauge 4 AIR INLET PRESSURE – Air inlet manifold pressure (absolute) is displayed in kPa or psi/10.

Gauge 5 ENGINE OIL PRESSURE – Pressure is displayed (gauge) in kPa or psi.

Note: Prelube oil pressure is indicated by a bar around the display for the oil pressure gauge. A solid bar indicates that the prelube pressure is OKAY. A flashing bar indicates that the prelube pressure is NOT OKAY.

Gauge 6 ENGINE LOAD – Load is displayed as a percentage of the full rated power output of the engine. The calculation of the percentage is based on the following factors: flow of fuel, engine rpm, and fuel energy content.

By setting the "GAUGE GROUP SELECT" switch to the right, the following engine functions are displayed on the gauge and the digital readout.

Gauge 7 OIL FILTER DIFFERENTIAL – The amount of pressure drop between the inlet and the outlet of the oil filter housing is displayed in kPa or psi.

Gauge 8 AIR RESTRICTION LEFT – The amount of pressure drop between the inlet (unfiltered) and outlet (filtered) sides of the air cleaner, displayed in kPa/10 or inches of $H_20/10$.

Gauge 9 CRANKCASE PRESSURE – This gauge indicates the pressure that is inside the crankcase. This is displayed in kPa/10 or inches of $H_20/10$

Gauge 10 COOLANT OUTLET PRESSURE – This gauge is not used.

Gauge 11 AIR RESTRICTION RIGHT – This gauge is not used with the G3600 engines.

Gauge 12 STARTING PRESSURE – This gauge indicates the air pressure that is available for starting the engine. This is displayed in kPa or psi.

The large gauge (center) always indicates the engine speed.

Gauge 13 ENGINE SPEED – This gauge displays engine speed in rpm (within 10 rpm).

CMS Fault Indicator Lights

The CMS has 12 lights that indicate a fault condition has occurred. A fault is either a measured parameter outside a safe limit or a malfunctioning device. Each light indicates the system to look for in determining the exact problem.

F1 CHECK GAUGES – One or more gauges indicate that a parameter is outside of the normal operating range. Check gauges.

F2 CHECK FLUID LEVELS – One or more fluid levels are below an acceptable limit. Observe the diagnostic code(s). Refer to Troubleshooting, SENR6510 for G3600 Engines.

F3 AUXILIARY EQUIPMENT – One or more problems exist in the interface for the driven equipment. Observe the diagnostic code(s). Refer to Troubleshooting, SENR6510 for G3600 Engines.

F4 FUEL SUPPLY SYSTEM – One or more problems exist in the system that controls the fuel. Observe the diagnostic code(s). Refer to Troubleshooting, SENR6510 for G3600 Engines.

F5 AIR INLET SYSTEM – One or more problems exist in the system that controls the inlet air. Observe the diagnostic code(s). Refer to Troubleshooting, SENR6510 for G3600 Engines.

F6 EXHAUST SYSTEM – One or more problems exist in the exhaust system. Observe the diagnostic code(s). Refer to Troubleshooting, SENR6510 for G3600 Engines.

F7 MODULES/WIRING – One or more problems exist with specific control modules and/or the wiring. Observe the diagnostic code(s). Refer to Troubleshooting, SENR6510 for G3600 Engines.

F8 COMBUSTION FEEDBACK SYSTEM – One or more problems exist in the controls for the feedback from the combustion system. Observe the diagnostic code(s). Refer to Troubleshooting, SENR6510 for G3600 Engines.

F9 IGNITION SYSTEM – One or more problems exist in the ignition system. Observe the diagnostic code(s). Refer to Troubleshooting, SENR6510 for G3600 Engines.

F10 SENSORS/DEVICES – One or more problems exist on specific control devices. This includes sensors, actuators, etc. Observe the diagnostic code(s). Refer to Troubleshooting, SENR6510 for G3600 Engines.

F11 STARTING SYSTEM – One or more problems exist in the engine starting system. Observe the diagnostic code(s). Refer to Troubleshooting, SENR6510 for G3600 Engines.

F12 DETONATION SYSTEM – One or more problems exist in the system that detects detonation. Observe the diagnostic code(s). Refer to Troubleshooting, SENR6510 for G3600 Engines.

Status Control Module (SCM)

The bottom of the control panel for the ESS contains the Status Control Module (SCM). This displays fault conditions and key engine parameters. The Status Control Module (SCM) accepts information from the operator, magnetic speed pickup (MPU), pressure/ temperature module and the Engine Supervisory System (ESS). This information is used to determine the "on/off" state of the engine's fuel and ignition system.

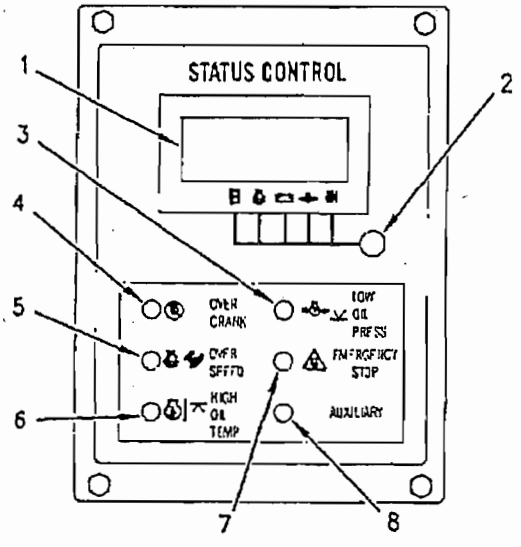


Illustration 20
Status Control Module (SCM)
(1) Liquid Crystal Display (LCD). (2) Switch (display hold switch). (3) Low Oil Pressure Light Emitting Diode (LED). (4) Overcrank LED. (5) Overspeed LED. (6) High Oil Temperature LED. (7) Emergency stop LED. (8) Auxiliary LED (shutdown).

The SCM receives a signal that instructs the SCM to start the engine. The SCM activates the fuel system and the starting motor. When the engine rpm reaches the crank termination speed, the starting motor is disengaged. When the SCM receives a signal to stop the engine, the fuel system is shut off.

The SCM has the following features:

Cycle Crank – The SCM can be programmed to crank-rest-crank for adjustable time periods.

Speed Control – When the engine oil pressure increases past the low oil pressure set point, the SCM will inform the ECM that the ECM should increase the engine speed from idle to rated.

Cooldown – After the SCM receives a signal to perform a normal shut down, the SCM will wait for a preprogrammed amount of time before shutting the engine off via the gas shutoff valve.

Automatic Operation – While in the automatic mode, the SCM can be started by a remote initiate signal. This signal is when the initiate contact (IC) closes. Upon the loss of the signal, the SCM will perform a normal shut down.

Power Down – The ESS system is designed to remove power when in the *off/reset* mode once the postlube cycle is complete. The SCM will not allow the engine to power down until the *Crank Termination Relay* and the *Fuel Control Relay* are both off. Both relays turn off two seconds after zero rpm.

Fuel Solenoid Type – The SCM can be programmed to work with either an Energize To Run (ETR) fuel system or an Energize To Shutdown (ETS) fuel system. In G3600 applications this must be an ETR system.

LED Display – Six LEDs are located on front of the SCM to annunciate overcrank shutdown, overspeed shutdown, low oil pressure shutdown, high oil temperature shutdown, emergency stop and auxiliary shutdown.

Emergency Stop – LED (7) will flash if the *Emergency Stop* button is used to stop the engine.

Pressure/Temperature Module Malfunction – If the signal from the engine mounted oil pressure/temperature transducer module is lost or unreadable, the engine will be shut down via the fuel control. A diagnostic

code will be displayed. The SCM can be programmed to ignore the malfunction of the transducer module.

Speed Pickup Malfunction – If the SCM loses the magnetic pickup signal, the engine will be shut down via the ignition system and the fuel control. A diagnostic code will be displayed.

Overcrank Protection – If the engine fails to start within a programmed amount of time, the SCM will cause the starting sequence to cease. LED (4) will flash. The mode control switch must be turned to the *Off/Reset* position before another attempt to start the engine can be made.

Liquid Crystal Display (1) – Service hours, engine speed, system battery voltage, engine oil pressure and engine oil temperature are sequentially displayed in either English or Metric Units. Pressing switch (2) on the front of the SCM will cause the display to lock (stop) on one of the engine parameters. Pressing the switch again will resume the display to normal sequencing. When a fault signal is detected, the display is also used to indicate diagnostic codes. This is to aid in troubleshooting. Refer to Systems Operation, Testing And Adjusting, Status Control Module (SCM), SENR6515, *Troubleshooting Section, Diagnosed Problems*.

Note: All diagnostic lights should turn on briefly when the panel is powered up. This is a light test.

Overspeed Protection – If the engine speed exceeds the set point for the overspeed, then the engine will be shut down via the ignition control and the fuel control. LED (5) will flash. The set point for the overspeed is lowered to 75 percent of the original value while the *Overspeed Verify* switch is depressed. This will allow the overspeed circuit to be tested while the engine is operating at rated speed.

Low Oil Pressure Protection – If the engine oil pressure drops below the low oil pressure set point, it will be shut down by means of the fuel control. LED (3) will flash. There are two set points for the low oil pressure. One set point is for when the engine speed is below the oil step speed. The another set point is for when the engine speed is above the oil step speed.

High Oil Temperature Protection – If the engine oil temperature exceeds the set point, the fuel will be shut off. LED (6) will flash. Refer to the Testing And Adjusting section of *G3612 and G3616 Engines Systems Operation and Testing & Adjusting Manual*, SENR5528, for status control module service procedure for information about testing and programming of the SCM.

Note: If a fault occurs and the control for the fuel does not shut down the engine, the ignition is shut off five seconds after the fault has occurred.

Engine Control Module (ECM)

The ECM monitors the fuel energy content for the air/fuel ratio control and for limiting the power. The ECM also has the function of system coordinator. The personality module of the ECM contains many of the protection set points. The personality module controls much of the systems operation. The display on the ECM consists of eight characters and eight lights.

The lights indicate:

STATUS (Green) – When this light is on, this light is for status information. Status information is the desired engine speed, fuel energy (Btu) setting, etc.

COMMUNICATION LINK 1 ACTIVE (Green) – When this light is on, this light will indicate that the ECM is properly communicating with the Timing Control Module (TCM).

COMMUNICATION LINK 2 ACTIVE (Green) – When this light is on, this light will indicate that the ECM is properly communicating with the Computerized Monitoring System (CMS Gauges), the Digital Diagnostic Tool (DDT) ports, and the optional Customer Communication Module (CCM).

CAUTION MODE (Yellow) – One or more problems exist. The code that indicates the exact nature of the condition will be displayed.

SENSOR FAULT (Red) – A problem with one of the sensors has been detected. One or more problems exist. The code that indicates the exact nature of the condition will be displayed.

ACTUATOR FAULT (Red) – A problem with one of the actuators has been detected. The code that indicates the exact nature of the problem will be displayed.

SYSTEM FAULT (Red) – A problem with one of the control systems has been detected. The code that indicates the exact nature of the problem will be displayed.

CONTROL MODULE FAULT (Red) – A problem with one of the control modules has been detected. The code that indicates the exact nature of the problem will be displayed.

The DISPLAY SELECT switch that is located on the right hand side of the ESS control panel door will allow the operator to step through the data on the Engine Control Module display. Every time the switch is toggled, the display steps through to the next item. Items displayed are either status codes or diagnostic codes. These codes are differentiated by one of the lights.

ECM Timing Control Module (TCM)

The Timing Control Module (TCM) maintains the ignition timing that is determined by the ECM. The TCM also protects the engine from unacceptable levels of detonation.

The TCM provides the ECM with information about detonation. The ECM sends a signal to the TCM for the engine timing that is desired. The signal can be retarded up to six crankshaft degrees if detonation is sensed. The engine will be shut down if high levels of detonation persist.

ECM Pyrometer Module

The pyrometer module allows the read out in nine separate temperatures in °C. The module powers up and displays the reading on channel zero (exhaust stack temperature). In order to read the temperature values on the other eight channels, press the *Push To Advance* button on the front of the gauge.

The pyrometer continuously compares channel zero (exhaust stack temperature) to a set point. If the exhaust stack temperature ever exceeds the set point, a contact closes. The ECM shuts down the engine.

Engine Control System

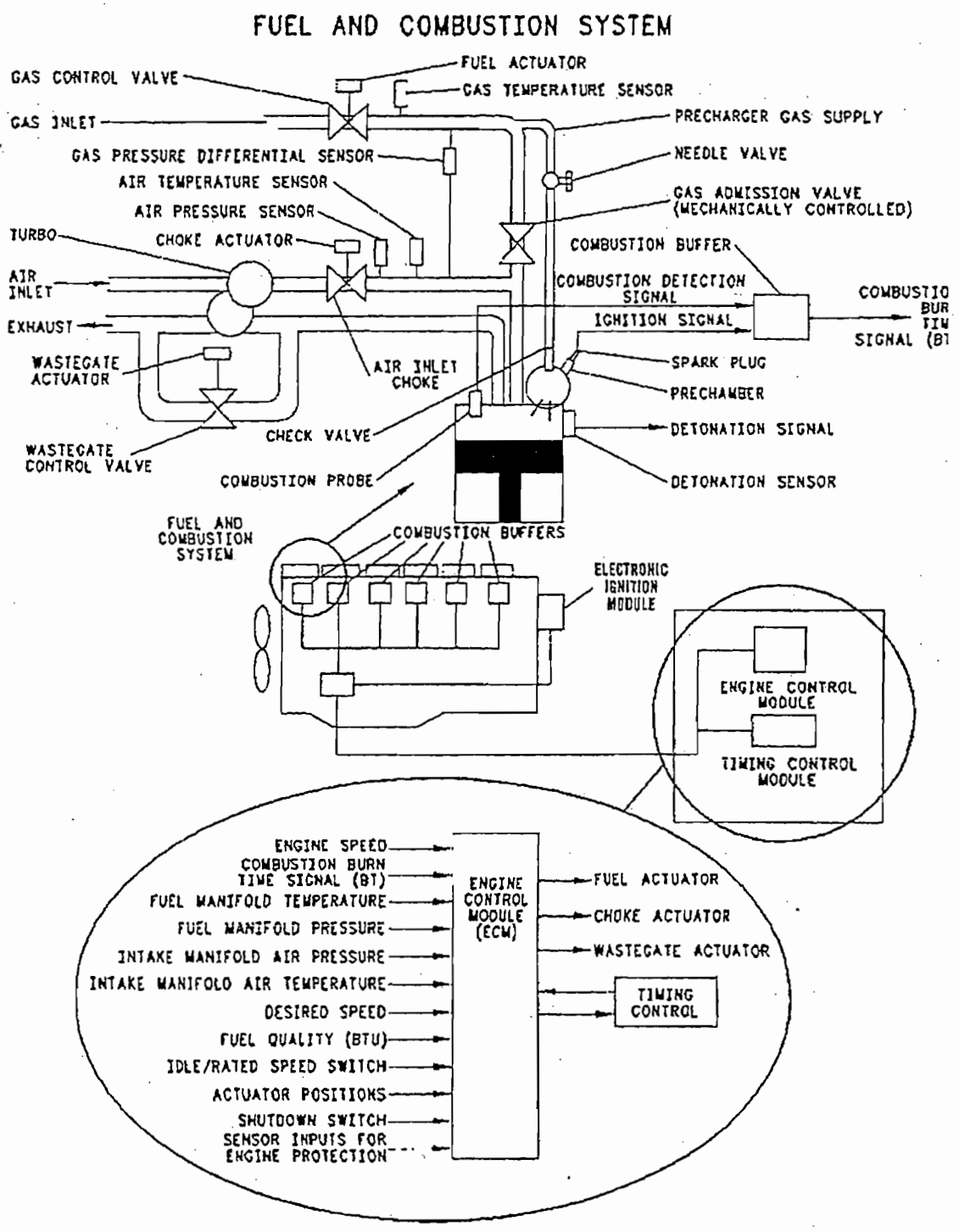


Illustration 21

The Engine Control System consists of the following components:

1. Engine Supervisory System (ESS) Control Panel
   - Engine Control Module (ECM)
   - Timing Control Module (TCM)
   - Desired Speed Potentiometer
   - Fuel Energy Content Potentiometer
2. Engine Mounted Sensors
3. Engine Mounted Actuators
   - Fuel
   - Wastegate
   - Choke

Governor

The Electronic Control Module (ECM) performs the governing function. The governor resembles a diesel engine governor more than a typical gas engine governor. The G3600 Engine is governed by modulating the fuel valve that controls the fuel flow independent of the air flow. The command signal that is sent from the ECM to the fuel actuator is based on the difference between the actual engine speed (as measured by the ECM magnetic pickup) and the desired engine speed.

Speed Droop

A setting from 0 to 10 percent speed droop can be selected by using the *Customer Selectable Parameter Screen, Number 31*, on the Digital Diagnostic Tool.

Switchable Governor Response

In order to provide a optimum engine response, with a generator set that operates in parallel with a utility or that operates with other generator sets, there must be two governor settings. The G3600 control system offers a dual dynamics governor. The *Governor Dynamics Switch* will select from either *Stand Alone* or *Paralleled* governor settings. Refer to Installation And Initial Start-up Procedures, SEHS9549, for information regarding switching from *OFF-GRID* to *ON-GRID* governor dynamics.

Desired Speed Control

Desired speed is controlled by an idle/rated switch. Open selects the idle speed of 550 rpm, closed selects the speed set by the desired speed potentiometer. The desired speed input is typically the potentiometer on the front face of the ESS panel. The desired speed may be controlled by an external input to the ECM. Refer to Installation And Initial Start-up Procedures, SEHS9549, for information regarding customer input.

Fuel Limiting

The governor provides the limiting of power on the G3600 Engine. The governor calculates the fuel flow. The governor compares the fuel flow against the maximum allowed flow. The governor protects the engine against over power situations.

Transient Fuel Limiting

In order to prevent the engine from operating at an air/fuel ratio that is excessively rich, the command signal that is sent to the fuel actuator may be limited. This will limit the amount of fuel flow into the engine during engine starting, engine acceleration or variable load operating conditions.

Personality Module

The Engine Control System contains a Personality Module. The Personality Module provides the engine application control maps. The Personality Module attaches to the ECM and the Personality Module communicates with the ECM. The Personality Module receives input from the engine control system sensors. The Personality Module monitors and controls the engine according to the parameters that are within the Personality Module. The Personality Module contains application specific engine control maps, protection set points and customer defined settings.

Air/Fuel Ratio Control

The G3600 Engine does not have a carburetor. The air flow and the fuel flow are independently controlled. The governor has complete control of the fuel flow. This leaves the air flow as the only parameter for adjusting the air/fuel ratio. The air flow is controlled by the exhaust wastegate system in order to maintain the desired air/fuel ratio or the desired combustion burn time (BT).

Fuel Flow

The ECM will calculate the fuel flow by using the following inputs:

- measured fuel manifold pressure
- measured fuel manifold temperature
- measured air inlet manifold pressure
- measured air inlet manifold temperature
- engine speed
- Btu setting

Air Flow

The ECM calculates the air flow based on the measured inlet manifold air pressure, the measured inlet manifold temperature, and the engine speed.

Desired Air/Fuel Ratio

The desired air/fuel ratio varies depending on engine speed and load. These values are stored in application specific maps in the Personality Module. These maps were created to achieve optimum engine performance (efficiency and emissions) as the engine speed and load varies.

Combustion Burn Time (BT)

Combustion Burn Time is the time measured for combustion flame propagation from the ignition spark in the precombustion chamber to the combustion sensing probe. The probe is mounted in the main combustion chamber.

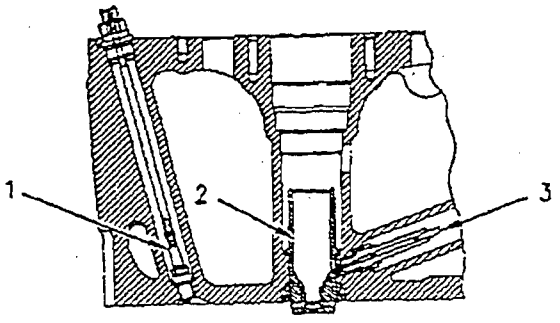


Illustration 22
Cylinder Ignition and Sensor
(1) Combustion sensor. (2) Precombustion chamber.
(3) Gas ignition spark plug.

In-cylinder combustion sensing for each cylinder, allows the engine to respond rapidly to changes in ambient conditions, fuel quality or speed and load changes. This results in a more precise control of the engine emissions and the fuel consumption. The combustion sensor is a nonconventional 14 mm (.55 in.) spark plug. The spark plug operates in conjunction with an electronic combustion buffer. This measures the actual time between the spark and the passage of the flame across the sensor. This information is averaged and compared with a desired map setting in the personality module. Corrections for variations in fuel quality, temperatures, etc. are made automatically as well as more quickly and accurately than manual adjustments.

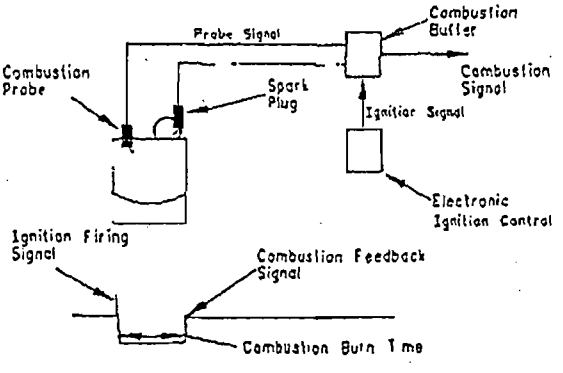


Illustration 23
Basic Combustion Probe System Diagram

The measured combustion burn time signals are sent to the ECM on two separate circuits. One circuit is dedicated to the Cylinder No. 1.

Another circuit sends the signals for the remaining cylinders to the ECM. The signals are received by the ECM in the firing order sequence.

Air Flow Control

Once the ECM has determined a desired air flow, the ECM modulates the exhaust bypass valve by changing the position of the wastegate actuator.

When the engine is operating in a normal operation mode, at an engine load that is typically greater than 50 percent, the air/fuel ratio is automatically controlled based on the average Combustion Burn Time (BT).

The position command signal that is sent from the ECM to the wastegate actuator is based on the difference between the average BT that is measured from the cylinders and the desired BT that is programmed into the personality module. Maintaining the desired BT ensures optimum engine performance and stable engine operation even when the quality of the fuel changes or when ambient conditions change.

When the engine is operating in precombustion chamber calibration mode or at an engine load that is typically less than 50 percent, the position command signal that is sent from the ECM to the wastegate actuator is the difference between the measured air/fuel ratio and the desired air/fuel ratio. The measured air/fuel ratio is a calculated value that is based on sensor inputs from the engine to the ECM. The inputs to the ECM that are required to calculate the air/fuel ratio are fuel manifold pressure, fuel manifold temperature, inlet manifold air pressure, inlet manifold air temperature, engine speed and fuel quality (Fuel Energy Content potentiometer setting). At start-up, the fuel energy content (Btu) is adjusted in order to agree with the fuel analysis by using the Fuel Energy Content potentiometer on the ESS control panel. When the engine is operating at greater than 50 percent load, the engine control overrides the manual fuel setting and provides fuel quality information. This is based upon the actual combustion burn time measurements that are taken during the combustion process. The manual setting of the Btu potentiometer will provide a starting point for the Air/Fuel Ratio Control system until the BT information is available from the combustion sensors.

Fuel Correction Factor

The fuel correction system will use the desired burn time along with the measured burn time in order to compute a fuel correction factor.

The percent fuel correction factor represents the difference in the actual energy content (Btu/ft^3) and the setting of the *Fuel Energy Content* potentiometer. The potentiometer is located on the front control panel of the ESS.

For example: the engine air/fuel ratio had been properly adjusted using a Btu dial setting of 900 Btu. After the engine has been running for a period of time, the quality of the fuel that is supplied to the engine will change from 900 to 990 Btu/ft^3. The result would be that the combustion flame would be faster. The ECM would slow down the combustion time by changing the air/fuel ratio to a leaner setting. The ECM would display a calculated fuel correction factor of 110 percent (990/900 times 100).

Fuel System

To ensure precise regulation of fuel flow on G3600 engines, carburetors are not used. Fuel flow is controlled electronically in order to maintain precise control of fuel delivery to the engine. The fuel system contains the following components: a gas shutoff valve, a fuel control valve, a electronic actuator, a fuel manifold, a gas admission valve, a needle valve, a check valve, and a precombustion chamber.

Gas is delivered to the engine through a customer supplied regulator (2). Fuel pressure must be 310 ± 14 kPa (45 ± 2 psi) and the fuel pressure must be regulated to 1.7 kPa (.25 psi). Lower fuel pressure may result in reduced power. The regulator is connected to a gas shutoff valve (3), which is controlled by the Engine Control Module (ECM).

Control valve (4), which is controlled by the electronic actuator (10) regulates the gas pressure in the fuel manifold (5). The electronic actuator controls the fuel manifold pressure. This control is based on a signal that was received from the engine control module. The engine control module determines the signal. The signal is based on the difference between the actual engine rpm and the desired engine rpm. Engine speed is controlled by the fuel manifold pressure. The fuel manifold (5) supplies gas to all cylinders.

Each cylinder has an orificed fuel line that is connected to the fuel manifold. The fuel line delivers gas to the gas admission valve (11) and from the gas admission valve on to the main combustion chamber. A separate fuel line (8) and adjustable needle valve (7) provide a new supply of gas to the precombustion chamber (12).

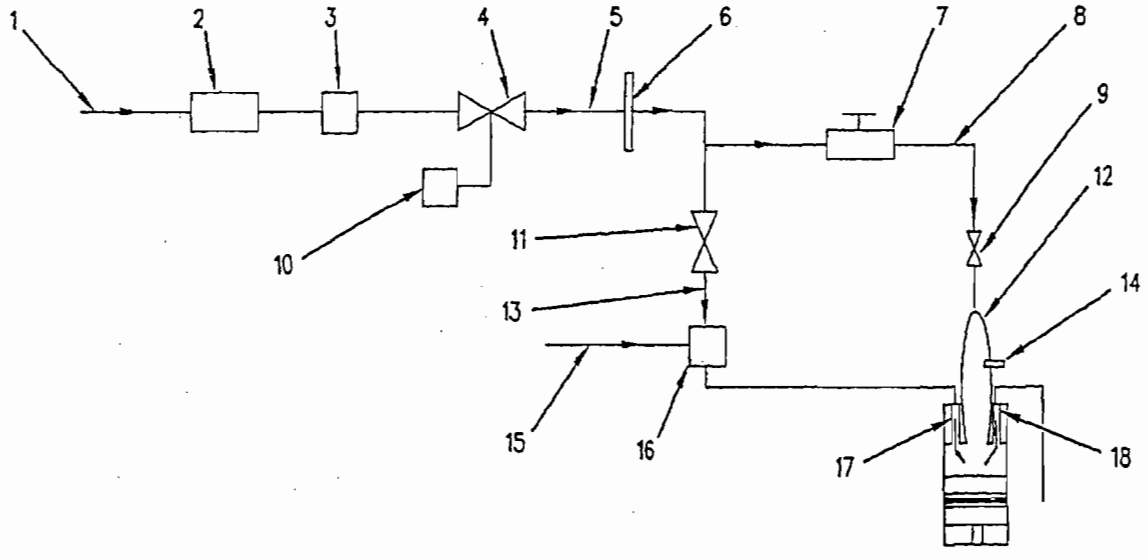


Illustration 24
Fuel System Schematic Diagram
(1) Gas input. (2) Customer supplied regulator. (3) Gas shutoff valve. (4) Control valve. (5) Fuel manifold. (6) Orifice. (7) Needle valve. (8) Precombustion chamber supply line. (9) Precombustion chamber check valve. (10) Electronic actuator. (11) Gas admission valve. (12) Precombustion chamber. (13) Main gas supply. (14) Spark plug. (15) Combustion air. (16) Cylinder head inlet port. (17) Inlet valve. (18) Exhaust valve.

Main Combustion Chamber

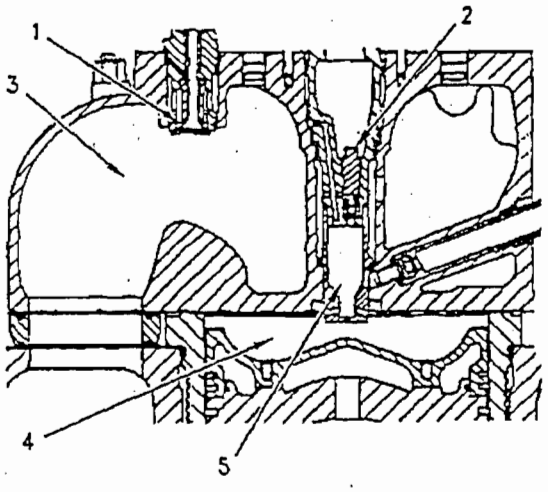


Illustration 25
(1) Gas admussion valve. (2) Check valve. (3) Inlet air.
(4) Main combustion chamber. (5) Precombustion chamber.

The gas admission valve (1) is mounted in the inlet port and is actuated by the camshaft. As the gas admission valve is opened, gas is admitted into the inlet port. The gas mixes with the combustion air in the inlet port. The gas and combustion air mix and flow into the cylinder.

Combustion air flow into the cylinder head is regulated (depending on the engine load) by the exhaust bypass valve (wastegate) and inlet air choke. As air flows into the cylinder head inlet valve chamber, the cam operated gas admission valve (1) admits gas to the air flow as the inlet valve opens. At the same time, an additional, separate, new gas supply is added to the precombustion chamber (5) through a ball type check valve (2).

Precombustion Chamber

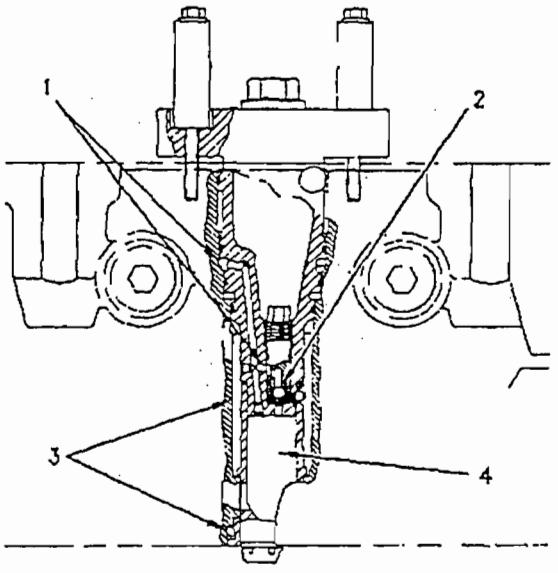


Illustration 26
PC Check Valve and Fuel Supply Path
(1) Fuel inlet passage. (2) Check valve. (3) Passageways for the jacket water coolant. (4) Precombustion chamber.

The new gas supply for the precombustion chamber (4) comes from the manifold. The new gas goes through a separate line and an adjustable needle valve. The new gas flows through the fuel inlet passage (1) into a ball type check valve (2). The check valve is located at the top of the precombustion chamber (4). The main charge of the air/fuel mixture flows through the inlet valves and into the cylinder. The check valve opens. The check valve adds new gas supply to the precombustion chamber. The gas in the precombustion chamber is ignited by the spark plug. The ignited gas in the precombustion chamber ignites the gas mixture in the cylinder in order to ensure consistent combustion and complete combustion.

Adjustment of the needle valve settings is a calibration procedure that is done by using the Digital Diagnostic Tool (DDT). The needle valve settings are adjusted in order to provide the desired combustion burn time. This depends on the engine speed and the engine load.

The need for low emissions and consistent combustion requires the use of an enriched precombustion chamber. To further enhance the overall effectiveness of this system, the side mounted spark plug is installed low in the precombustion chamber. With this design, the initiation of the flame front in the precombustion chamber is near the outlet to the main combustion chamber. This ensures that the rich fuel mixture is more completely burned prior to entering the main chamber than the fuel mixture would be burned if the ignition source was at the top of the precombustion chamber. Mixing of the fuel in the precombustion chamber with the lean combustion air from the main chamber during cylinder compression, yields an optimum air/fuel mixture for initiation of combustion.

Ignition System

The components of the gas engine ignition group and the fully shielded ignition system wiring are used with the magneto in order to provide spark ignition.

Ignition Transformer

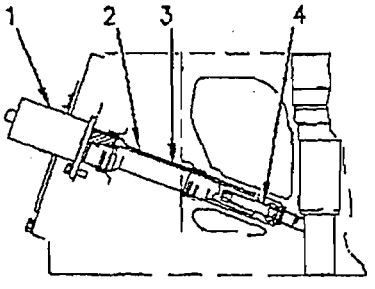


Illustration 27
Components of the Gas Engine Ignition Group
(1) High energy ignition transformer. (2) Tube.
(3) Extension with a spring loaded rod. (4) Spark plug.

The ignition transformer causes an increase of the primary voltage. The increased voltage is needed to send a spark (secondary electrical impulse) across the electrodes of the spark plugs. For good operation, the connections (terminals) must be clean and tight. The negative transformer terminals for each transformer are connected together and the terminals are connected to ground.

Timing Control System

The Caterpillar Detonation Sensitive Timing Control (DSTC) system provides detonation protection for the engine and electronic adjustment of ignition timing with a variable timing.

Timing Control System

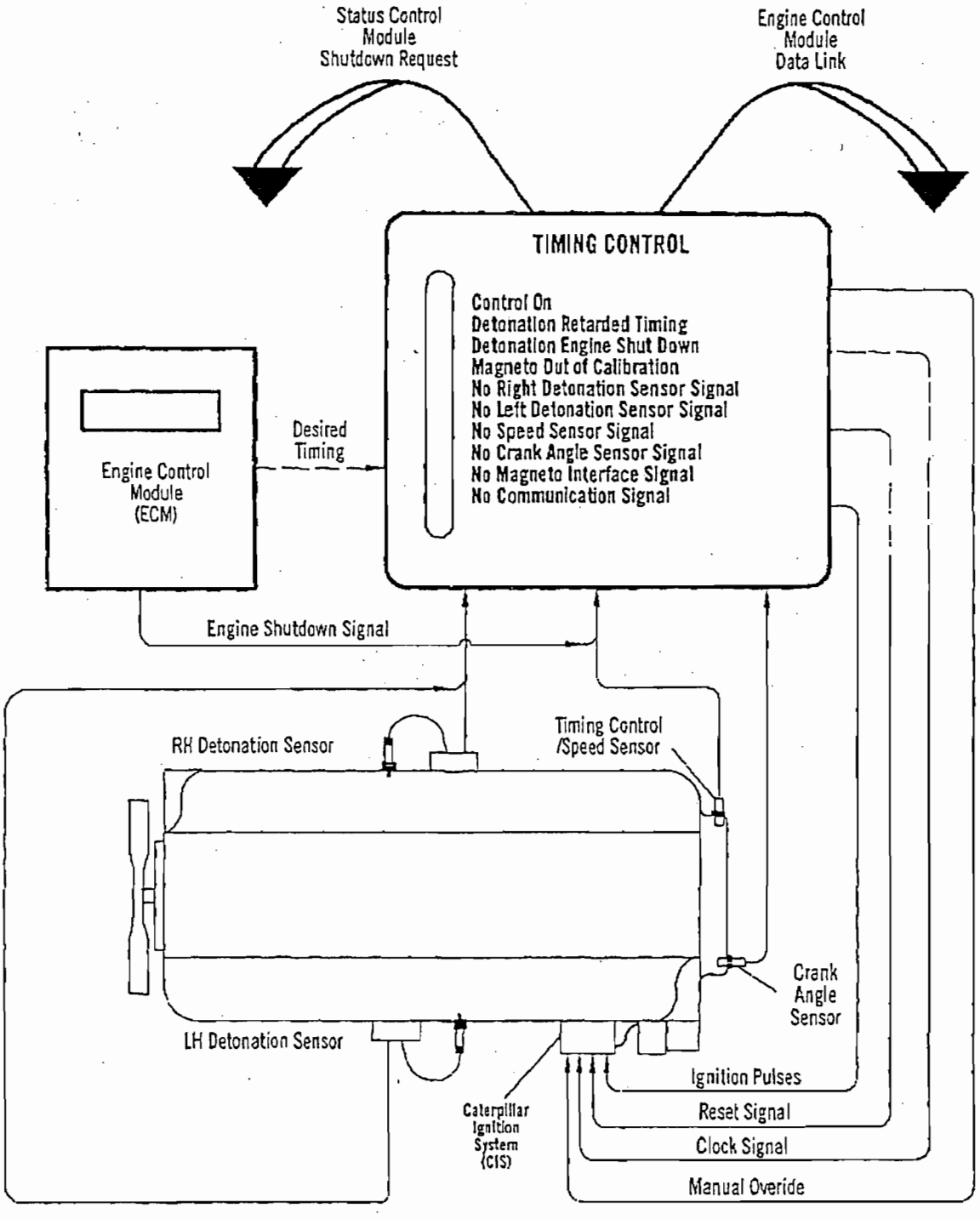


Illustration 28

Timing Control Module (TCM)

The TCM determines the ignition timing. The TCM communicates the ignition timing with the Caterpillar Ignition System (CIS). The TCM provides the system diagnostics.

Engine timing, controlled by the TCM, is based upon the desired timing signal received from the ECM. The desired timing signal from the ECM varies depending on engine speed, engine load and engine detonation.

The ignition timing is controlled by three signals that are sent from the TCM to the CIS. The CIS sends a signal that indicates that the plug is firing to the TCM. The TCM uses this signal to calculate actual engine timing.

Timing Control Sensors

The TCM uses two sensor signals for the ignition timing control. The TCM uses the detonation sensors for detonation protection. The Crank Angle Sensor (CAS) and the Speed Sensor (TCMPU) provide top center (TC) and rotational position needed to control timing. The detonation sensors provide an electrical signal of the engine's mechanical vibrations that are used in order to calculate the detonation levels.

Crank Angle Sensor (CAS)

This passive magnetic speed sensor indicates the crankshaft angle to the TCM. The crank angle sensor provides the TC signal used to control timing and calculate actual timing. The signal is generated when the TC hole (for the No. 1 piston) in the flywheel face passes the sensor.

Speed Sensor (TCMPU)

This passive magnetic speed sensor indicates engine speed to the TCM. The speed sensor produces a signal whenever a ring gear tooth on the flywheel passes the sensor. The signal is used to calculate engine speed, to monitor the crankshaft angle between TC pulses and to clock the MIB electronics.

Detonation Sensors

The detonation sensor is a powered device that outputs a filtered electrical signal and a amplified electrical signal of the engine's mechanical vibrations. When increased levels of vibration are occurring, the ECM calculates the engine detonation. If necessary, the ECM will adjust the ignition timing in order to control detonation. This is done by sending a desired timing signal that is retarded as much as six crank degrees to the TCM, When the level of vibration has returned to normal, the ECM will adjust the desired timing signal in order to gradually allow the ignition timing to return to operation. This adjustment is based on the desired timing map that is part of the personality module.

G3600 Ignition Timing System

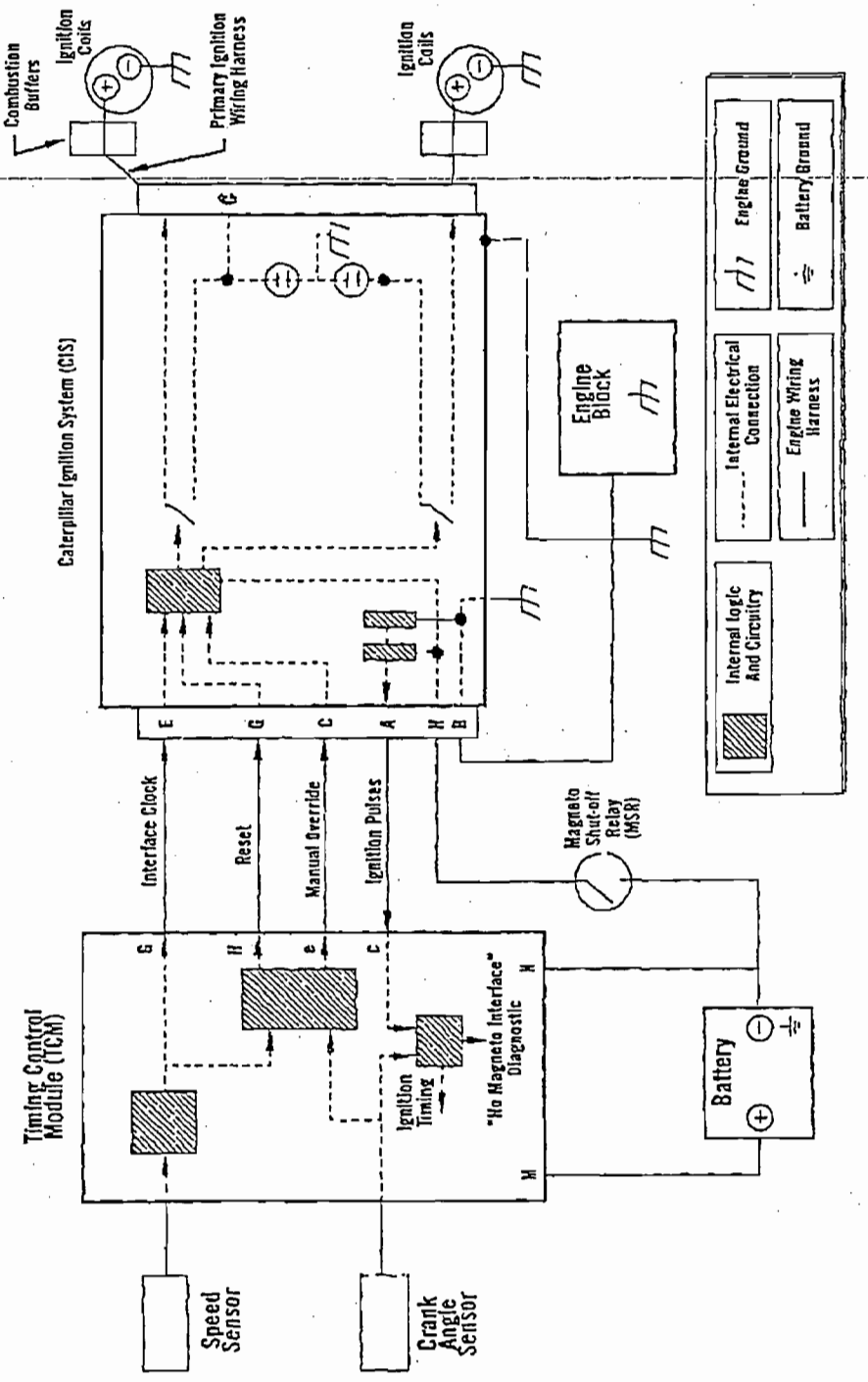


Illustration 29

The Timing Control provides three signals to the Caterpillar Ignition System (CIS) in order to communicate the desired ignition timing. These signals are the Ignition Interface Clock, the Reset Pulse signal, and the Manual Override signal. The CIS returns the Ignition Pulses to the Timing Control. The Timing Control calculates the Actual Engine Timing. The Timing Control performs some ignition diagnostics from this signal.

Ignition Interface Clock

The Ignition Interface Clock signal is a square wave version of the speed sensor signal. This signal provides a timing clock for the CIS.

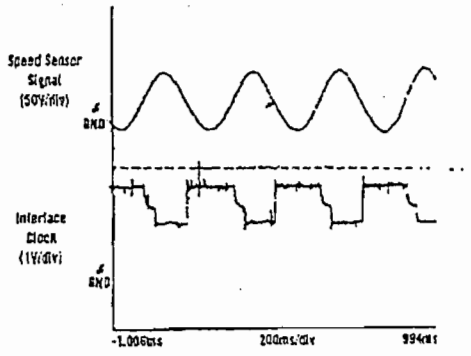


Illustration 30
Relationship Between Speed Sensor and Clock Signals

Sent from Timing Control (pin-G) to CIS (pin-E, 10 pin Connector).

The waveform is a square wave version of the speed sensor signal, with peak voltage of 2.5 V and minimum voltage of 1 V. The positive-going edge of the clock signal should align with the negative-going zero-crossing of the speed sensor signal.

Reset Pulse

The Reset Pulse signal indicates to the CIS the ignition timing desired by the Timing Control. The pulse is sent once from TC to TC.

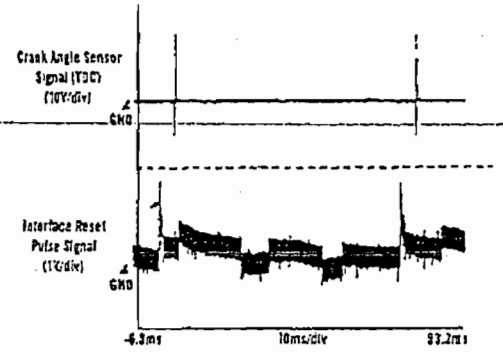


Illustration 31
Interface Reset Pulse Signal Relative to Crank Angle TC Signal

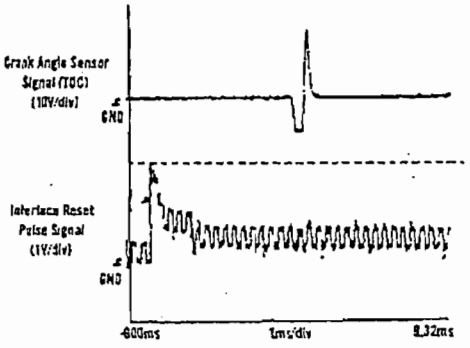


Illustration 32
Close Up of Interface Reset Pulse Signal Relative to Crank Angle TC Signal

Sent from Timing Control (pin-H) to CIS (pin-G, 10 pin Connector).

The Interface Reset Pulse signal is normally below 1 V. The Reset Pulse goes high to about 2.5 V. This signal should go high once from Top Center (TC) to TC.

Manual Override ("Mag Cal" Mode As Seen In DDT)

The Manual Override signal tells the CIS to control fully advanced ignition timing.

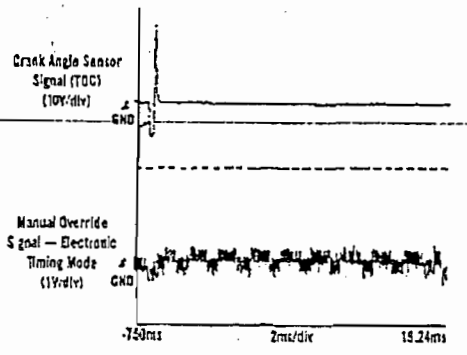


Illustration 33
Manual Override Signal, Timing Control in Electronic Timing Mode

Sent from Timing Control (pin-E) to CIS (pin-C, 10 pin Connector).

The manual override signal should remain below 1 V when the system is in Electronic Timing Control mode. A 5 V signal on this line will tell the CIS to run the ignition at fully advanced timing.

Ignition Pulses

The Ignition Pulse signal is the odd number bank's capacitor charge. The signals waveform indicates the discharge of the CIS and firing of cylinders. One pulse is shown for each number cylinder. This signal is used by the TCM to calculate ignition timing and some ignition diagnostics.

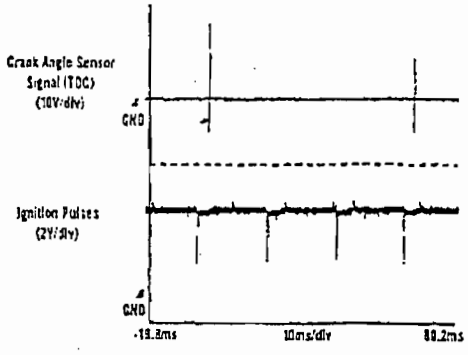


Illustration 34
Ignition Pulses Relative to Crank Angle TC Signal (Six Cylinder Engine)

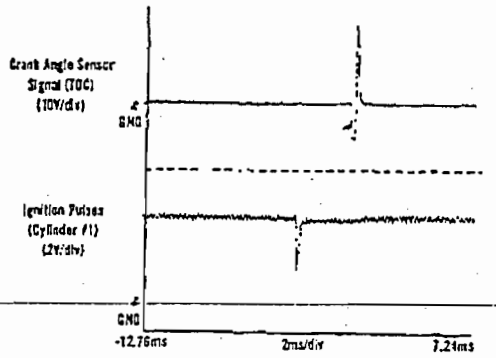


Illustration 35
Close Up of Ignition Pulses Relative to Crank Angle TC Signal (Six Cylinder Engine)

Sent from CIS (pin-A, 10 pin Connector) to Timing Control (pin-C).

From TC to TC, this waveform should show one pulse for each number cylinder. The pulse is normally at 5 V and goes below 2 V when the MIB detects the ignition firing.

Interaction Of The Interface Signals

The manual override signal is held below one volt, the CIS is placed in *Mag Cal* Mode. The TCM generates the Clock signal by squaring the Speed Sensor (TCMPU) signal. This clock signal is used by the CIS electronics in order to keep track of the rotational position. When the the Reset pulse is received from the TCM, the CIS counts nine Clock signal edges. The CIS will then signal to fire Cylinder Number One. The CIS continues to monitor the Clock. The CIS signals to fire the remaining cylinders through the rotation. When the CIS discharges to fire the cylinder, an ignition pulse is generated. The Ignition Pulse signal is a reduced voltage signal of the odd number bank's capacitor voltage. Ignition Timing is calculated by comparing the timing offset between TC from the Crank Angle Sensor and the Ignition Pulse for Cylinder Number One.

When the Manual Override signal goes above one volt, the CIS operates in Manual (Standard) Mode. The CIS will no longer control ignition firing. The CIS will generate an ignition pulse at the most advanced ignition timing. The Ignition Timing is calculated in the same manner as in Electronic Timing Mode.

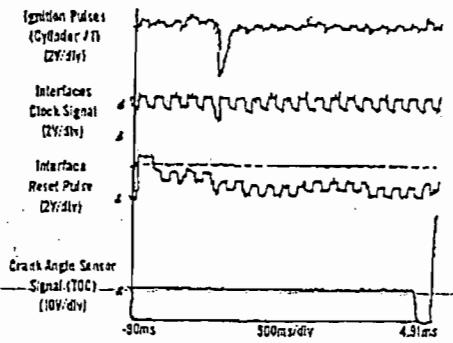


Illustration 36
Interaction of Reset, Clock, Ignition Pulse and TC Signal

When the CIS receives the Reset Pulse, the CIS generates a ignition pulse after 9 Clock Signal edges (both rising and falling edges). The CIS generates the Ignition Pulse for Cylinder Number One. This should occur before the TC signal of the engine.

Ignition Pulse Firings

From TC to TC, this waveform should show one pulse for each cylinder. The pulses should go from 190 V to ground when the cylinder is signaled to fire.

Engine Start-up

At engine start-up, the Timing Control performs some system checks not done once the engine is running. The Manual Override signal places the CIS in Manual Mode until the engine speed is above 500 rpm. Once the engine speed increases between 300 and 500 rpm, the Timing Control will compare the timing of Cylinder No. 1 firing to the *Mag Cal* Timing stored in internal memory. If the two timing values do not match, the Timing Control will display the "Magneto Out Of Calibration" fault.

CATERPILLAR®

G3600 Ignition System

Ignition System

General Information

System Operation

Caterpillar Gas Engines use a low tension ignition system. The low tension ignition system provides dependable firing with low maintenance. An ignition transformer is mounted near the spark plug for each cylinder. The ignition transformer converts the low level primary voltage to the high level secondary voltage required to arc across the J-gap spark plug. An extension piece connects the spark plug to the ignition transformer secondary.

The low level primary voltage (approximately 200 volts) is generated by a magneto. The magneto is mounted at the rear of the engine and driven by the camshaft. The variable timing magneto contains a permanent magnet alternator and solid-state electronic switches to control ignition firing.

The Timing Control System provides electronic control of the engine timing. This system controls the variable timing magneto to provide optimum engine timing during steady-state and transient operating conditions. Timing accuracy is controlled to within ±0.7 degrees of crank angle. This system also provides detonation sensitive timing. The Timing Control System will retard engine timing when a level of detonation is reached that might damage the engine.

A normal engine shutdown is accomplished by shutting off the fuel supply. The ignition system continues to operate until the engine is below 50 rpm. This allows the engine to consume the fuel that is trapped between the shutoff valve and the cylinder. The ignition system is disabled for engine overspeed and emergency stop shutdowns.

Digital Diagnostic Tool (DDT) Service Tool

A DDT service tool can be used to read the actual and desired engine timing. The DDT is also used to set the ignition system into the magneto calibration "MAG CAL" mode. The "MAG CAL" mode allows the magneto to be manually adjusted to the magneto calibration setting of 28 ± 1 degree. The DDT does not display a desired timing in the "MAG CAL" mode but does display the actual engine timing.

Engine Timing Reference

Many procedures on the engine require a timing reference. The G3600 Gas Engines are considered "in time" when the number 1 cylinder is at top-dead-center position on the compression stroke, the crankshaft timing pin is engaged in the bracket attached to the crankshaft and the camshaft timing pin is engaged in the hole in the camshaft assembly.

Engine Rotation

SAE standard engine rotation is counterclockwise as seen from the flywheel end of the engine.

Note: The front end of the engine is opposite the flywheel end. Left side and right side are as seen from the flywheel end of the engine. The number 1 cylinder on the G3606 and G3608 engines is the front cylinder. The number 1 cylinder on the G3612 and G3616 engines is the front right cylinder.

Hazardous Location (CSA)

Factory certification by the Canadian Standards Association (CSA) is available. With an attachment design, the G3600 Gas Engine is approved for use in Class 1, Division 2, Group D hazardous locations. CSA approval is required for engines operating in hazardous locations in Canada. CSA certification is recognized by many authorities outside of Canada as well.

Power for Auxiliary Panels

The G3600 Engine Supervisory System control panel requires 24 VDC for operation. The power source for this system can also be used to power auxiliary panels. The magneto should not be used to power auxiliary panels. All magneto power is required to provide optimum engine operation and maximum spark plug life.

Electrical Schematics
Electrical schematics are shipped with the engine and should be kept with the service manual. All ignition system components, wiring, and terminal connections are shown in the schematic.

Components–Engine Mounted

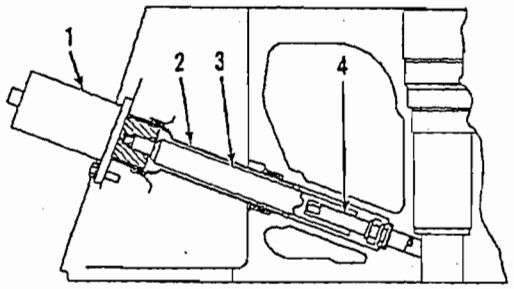


Figure 1: Ignition Group Components
(1) High energy ignition transformer. (2) Tube.
(3) Extender with spring loaded aluminum rod.
(4) Spark plug.

Spark Plugs
An 18 mm J-gap type spark plug (4) is mounted in each cylinder head with the firing end extending into and positioned low in the prechamber insert (see Figure 1). The spark plugs include precious metal electrodes for durability and resistance to electrical erosion. Other features developed for this application include copper-cored electrodes for better heat transfer, and a ceramic resistor for electrical noise suppression.

Failure to use recommended plugs, or failure to properly maintain the spark plugs will affect the engines fuel consumption, emissions, and steady-state stability.

Spark Plug Extenders
The spark plug extenders (3) provide the high voltage electrical connection from the ignition transformer secondary to the spark plug terminal. The one piece extender consists of a brass center electrode and spring-loaded tip within a Teflon insulator.

Ignition Transformers
An ignition transformer (1) is mounted on each cylinder head side cover. The ignition transformer converts the low level primary voltage (approximately 200 Volts) from the magneto to the high level secondary voltage (3,000-30,000 Volts) required to arc across the spark plug J-gap.

There is a separate pin on the magneto output connector for each ignition transformer. The ignition transformers are connected to the magneto output connector by wiring that is installed in a metal conduit assembly. Each ignition transformer primary coil positive terminal is connected to a solid-state electronic switch in the magneto. The wires from the primary coil negative terminals are connected together and attached to the engine block near the magneto.

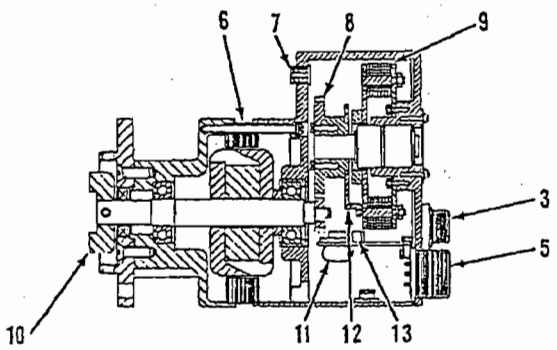


Figure 2. Cross Section Of Solid State Magneto
(3) Magneto interface box input connector.
(5) Magneto output connector. (6) Magneto alternator.
(7) Vent. (8) Speed reduction gears. (9) Pick-up coil.
(10) Drive tang. (11) Energy storage capacitor. (12) Rotating timer arm. (13) SCR solid state switch.

Magneto
The variable timing magneto (Figures 2 and 3) contains a permanent magnet alternator and solid-state electronic switches to control ignition firing. The magneto is mounted at the rear of the engine on the camshaft cover.

A drive gear from the camshaft turns the magneto drive tang (10). The drive tang turns the permanent magnet alternator (6), speed reduction gears (8), and the rotating timer arm (12). As the alternator is turned, it provides power to charge the storage capacitor (11). The G3612 and G3616 magnetos contain two storage capacitors, one stores the charge to fire the right bank (odd

numbered) cylinders and the other fires the left bank (even numbered) cylinders. There are separate stationary pick-up coils (9) and solid-state switches (13) for each cylinder.

Two conditions must be met before the storage capacitor will discharge across an ignition transformer primary. The switch in the Magneto Interface Box (MIB) and a solid-state switch in the magneto must be closed. The voltage from the storage capacitor is sent to the MIB and then back to the solid-state switches in the magneto through the magneto interface box connector (3). The switch in the MIB is controlled by signals from the Timing Control System. While the rotating timer arm is over a pick-up coil, the solid-state switch in the magneto paired with that pick-up coil is closed.

Note: The maximum ambient air temperature for magneto operation is 85°C (185°F).

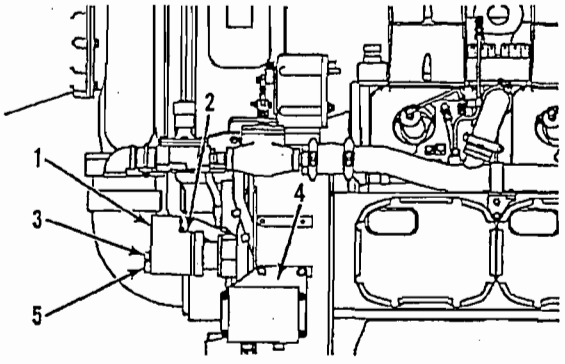


Figure 3: Solid State Magneto
(1) Electronic firing section of magneto. (2) Alternator section of magneto. (3) Magneto interface box input connector. (4) Magneto interface box. (5) Magneto output connector.

Magneto Interface Box

The Magneto Interface Box (MIB) is mounted near the magneto at the rear of the engine. The MIB is an interface between the Timing Control System and the magneto. The Timing Control Module sends signals to the MIB that control when the spark plugs fire. The MIB returns a signal to the Timing Control Module when the spark plugs fire.

Crank Angle Sensor

The crank angle sensor is mounted in a bracket above the flywheel. This passive magnetic pick-up indicates crankshaft angle to the Timing Control Module. A pulse is generated when the Top-Dead-Center (TDC) hole in the flywheel passes beneath the sensor. The TDC pulse is required to calculate actual engine timing.

Speed Sensor

The speed sensor is mounted in a bracket above the ring gear. This passive magnetic pick-up generates a pulse whenever a ring gear tooth on the flywheel passes beneath the sensor. There are 255 teeth on the ring gear. The pulses are used to calculate engine speed, monitor crankshaft angle between the crank angle sensor pulses, and provide a clock signal for the magneto interface box.

Detonation Sensor

The detonation sensor consists of an accelerometer body with a short steel jacketed wiring connection to an electronic buffer unit. The accelerometer body is threaded into the cylinder block and the buffer unit is mounted on a plate nearby. The detonation sensor outputs a filtered and amplified electrical signal that represents the engine's mechanical vibration. This signal is processed by the Timing Control System and used to provide detonation protection.

Components-Remote Mounted

Timing Control Module

The Timing Control Module (TCM) is located inside the ESS control panel and is visible through the window on the front of the panel. The TCM receives information from the Crank Angle Sensor, Speed Sensor, Detonation Sensors, and the Engine Control Module. This information is used to control engine timing.

The TCM controls the engine timing based upon the set point determined by the Engine Control Module (ECM). This is accomplished by receiving the desired timing set point from the ECM over a dedicated data link and generating the proper control signals for the magneto interface box. The TCM returns its status (caution and fault codes) along with the

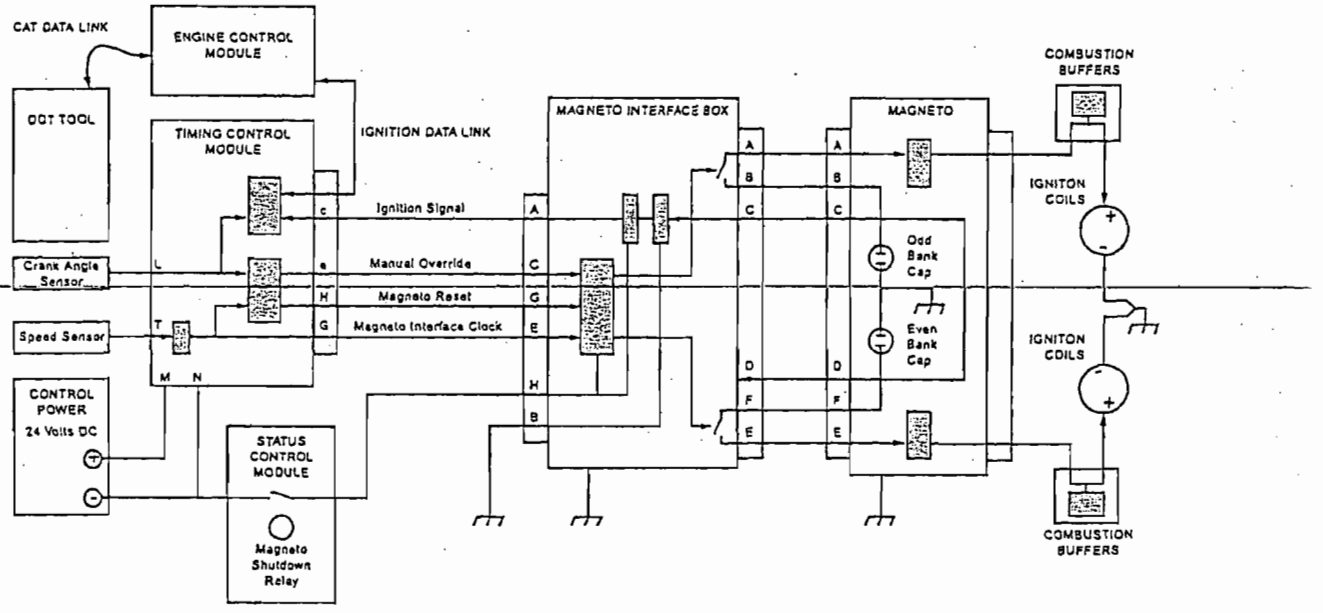


Figure 4: G3600 Ignition Timing System.

actual timing and the detonation level to the ECM for processing.

Ignition Timing System

System Operation

The Engine Supervisory System (ESS) integrates several control subsystems installed on the engine. With the ability to communicate with the various subsystems, the ESS optimizes each controlled parameter to ensure maximum engine performance. The subsystems include start/stop/prelube logic, engine monitoring and protection, and engine control which includes the Ignition Timing System (Figure 4). The ESS panel is the control center for the Engine Supervisory System and houses the control modules of each subsystem. The Timing Control Module (TCM) (Figure 5) maintains the ignition timing at the set point determined by the Engine Control Module (ECM). This is accomplished by receiving the desired timing set point from the ECM across a dedicated data link and generating the proper control signals for the magneto interface box.

Timing Control Module (TCM) Control Signals

When the manual override signal is held below 1 volt and engine speed is greater than 500 rpm, the ignition system operates in the electronic timing mode. The Timing Control Module (TCM) generates the magneto interface clock signal which the Magneto Interface Box (MIB) uses to keep track of the engines rotational position. The magneto interface clock signal is a square wave version of the speed sensor signal. The TCM sends a magneto reset pulse once per crankshaft revolution. When the MIB receives the magneto reset pulse, it counts 9 magneto interface clock signal edges and then closes the switch in the MIB which fires a cylinder. The MIB continues to monitor the magneto interface clock signal and fires the remaining cylinders in the rotation. When the magnetos odd bank capacitor discharges to fire a cylinder an ignition pulse is generated. The ignition signal is a reduced voltage version of the ignition pulse.

The TCM calculates the engine timing by comparing the timing offset between the ignition signal for cylinder 1 and the Top-Dead-Center (TDC) pulse from the crank angle sensor.

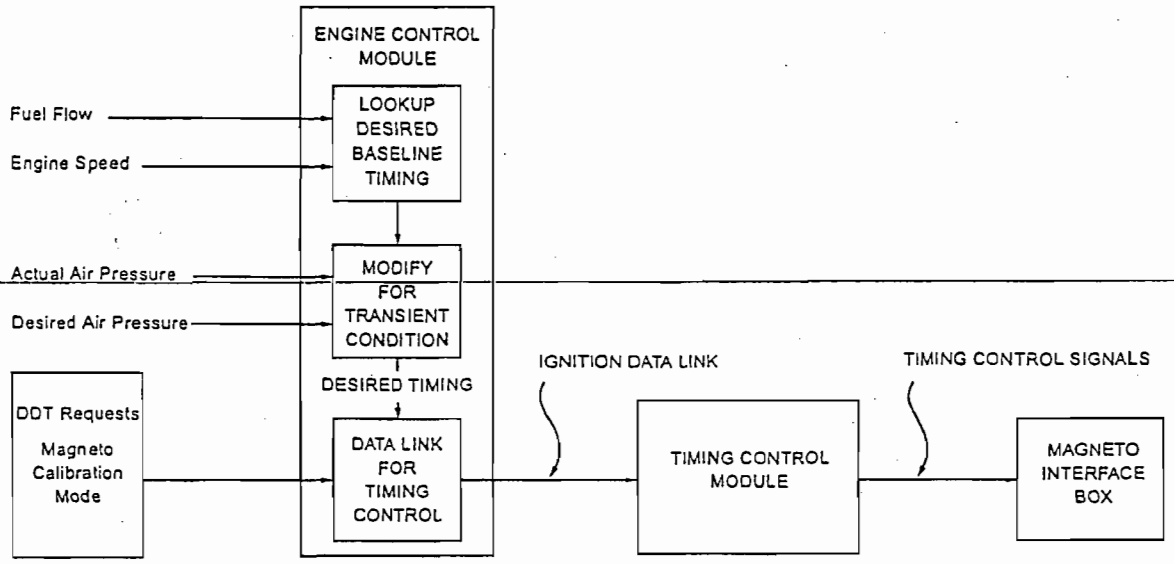


Figure 5: G3600 Ignition Timing Control Logic

When the manual override signal is above 1 volt, the ignition system operates in the magneto calibration "MAG CAL" mode. A DDT service tool is used to request the "MAG CAL" mode. In the "MAG CAL" mode, electronic timing is disabled. The solid-state switches in the MIB are always closed and ignition timing is fully advanced to 28 ± 1 degree. In "MAG CAL" mode, a spark plug will fire as soon as the timing arm in the magneto enters the pick-up coil field associated with that plug. The ignition timing is calculated in the same manner as it is in the electronic timing mode.

At engine start-up the Ignition System operates in the "MAG CAL" mode until the engine is above 500 rpm. The TCM checks for the ignition pulse firing signal from cylinder 1 between 120 and 300 rpm. The TCM will display the "No Magneto Interface Signal" fault if this ignition pulse is not detected for 0.3 seconds. Between 300 and 500 rpm the TCM compares the current timing of cylinder 1 with the "MAG CAL" timing stored in internal memory. The "Magneto Out of Calibration" fault will be displayed if the two values do not match.

Ignition Timing Control Logic

The primary function of the Engine Control Module (ECM) is to govern the engine speed and control the air/fuel ratio. It also has the role of systems coordinator. The software to operate the ECM is stored in a personality module that is mounted on the front of the ECM. The personality module contains many of the protection set points and stores the maps that are used for engine control. The map to control the ignition timing is stored in the personality module.

A DDT service tool connected to the Cat Data Link can be used to read the actual and the desired engine timing. The information on the Cat Data Link is sent from the ECM. The DDT is also used to place the ignition system in the magneto calibration "MAG CAL" mode. The ECM receives the request from the DDT and flags the Timing Control Module (TCM) to operate in the "MAG CAL" mode. In "MAG CAL" mode, the solid-state switches in the MIB are always closed and the ignition timing is fully advanced to 28 ± 1 degree.

If the DDT is not requesting "MAG CAL" mode, the ECM flags the TCM to operate in electronic timing mode. In electronic timing mode the ECM sends the desired timing set

point to the TCM over a dedicated data link. The desired timing set point is selected from the ignition timing map based on fuel flow and engine speed. The set point value is modified during transient conditions based on the actual and desired inlet manifold air pressure.

The ECM also uses the detonation level from the TCM to retard the engine timing if excessive levels of detonation are measured. The retarded timing essentially reduces the peak cylinder pressure.

Customer Connections

The only customer connections required to complete the ignition system are control power for the ESS panel and interconnect wiring between the ESS panel and the engine mounted junction box.

Two interconnect harnesses are available from Caterpillar to complete the wiring from the ESS panel to the junction box. One harness contains all wiring required for the start/stop/prelube systems, monitoring and protection system, and control systems which includes the ignition wiring. The other harness connects the engine thermocouples to the pyrometer(s) in the ESS panel. The harnesses are available in lengths of 20, 50, and 100 feet.

Reference Material

Special Instruction - *Installation and Initial Start-Up*. SEHS9708 for G3608 and G3606. SEHS9549-01 for G3616 and G3612.

This publication provides the information required to install the interconnect wiring between the ESS panel and the engine mounted junction box and completes the initial engine start-up.

Electrical Schematics – Wiring schematics are shipped with the engine and should be kept with the service manual. All ignition system components, wiring, and terminal connections are shown in the schematic.

Service Manual - *Systems Operation Testing and Adjusting*. SENR4258-03 for G3608 and G3606. SENR5528-03 for G3616 and G3612.

Attachment 9

Proposed Replacement
Engine Driven Pump and Generator No. 1

3508 Prime Power Generator Set
820 kW Power Rating
Emissions
Systems Operation

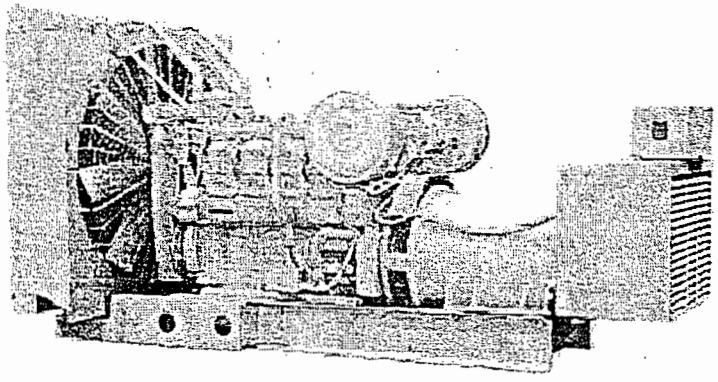
Alexander Orr, Jr.
Water Treatment Plant

CATERPILLAR®

Generator Set

3508
Prime Power

650-820 kW 60 Hz



Shown with
Optional Equipment

SPECIFICATIONS

V-8, 4-Stroke-Cycle Watercooled Diesel

Bore—mm (in)	170 (6.7)
Stroke—mm (in)	190 (7.5)
Displacement—L (cu in)	34.5 (2,105)
Compression Ratio	13.5:1

CATERPILLAR ENGINE FACILITIES ISO 9001 CERTIFIED

FEATURES

■ **CAT® DIESEL GENERATOR SETS**
Factory designed, certified prototype tested with torsional analysis. Production tested and delivered to you in a package that is ready to be connected to your fuel and power lines. EPG Designer computer sizing available. Supported 100% by your Caterpillar dealer with warranty on parts and labor. Extended warranty available in some areas. The generator set was designed and manufactured in an ISO 9001 compliant facility. Generator set and components meet or exceed the following specifications: AS1359, AS2789, ABGSM TM3, BS4999, DIN6271, DIN6280, EGSA101P, JEM1359, IEC 34/1, ISO3046/1, ISO DIS8528, NEMA MG1-22.

■ **RELIABLE, FUEL EFFICIENT DIESEL**
The compact, four-stroke-cycle diesel engine combines durability with minimum weight while providing dependability and economy. The fuel system operates on a variety of fuels.

■ **CATERPILLAR® SR4 GENERATOR**
Single bearing, wye connected, static regulated, brushless permanent magnet excited generator designed to match the performance and output characteristics of the Caterpillar diesel engine that drives it.

■ **EXCLUSIVE CATERPILLAR VOLTAGE REGULATOR**
Three-phase sensing and Volts per Hertz regulation give precise control, excellent block

CATERPILLAR® SR4 GENERATOR

Type	Brushless, revolving field, solid-state exciter
Construction	Single bearing, close coupled
Three phase	Wye connected
Insulation	Class F with tropicalization and antiabrasion
Enclosure	Drip proof IP 22
Alignment	Pilot shaft
Overspeed capability	150%
Wave form	Less than 5% deviation
Paralleling capability	Standard with adjustable voltage droop
Voltage regulator	3-phase sensing with Volts-per-Hertz
Voltage regulation	Less than ± 1/2%
Voltage gain	Adjustable to compensate for engine speed droop and line loss
TIF	Less than 50
THF	Less than 3%

CATERPILLAR CONTROL PANEL

24 Volt DC Control
Vibration isolated
NEMA 1, IP 22 enclosure
Dead front
Lockable hinged door
Generator instruments meet ANSI C-39-1

Voltages Available
60 Hz
139/240, 227/480
346/600, 380, 4160

(Adjustable a minimum of ±10%)
Other voltages available–consult your Caterpillar dealer.

STANDARD EQUIPMENT

Engine
Aftercooler
Air cleaner
Breather, crankcase
Cooler, lubricating oil
Exhaust fitting and flange
Filters, right hand
  fuel, full flow
  lubricating oil, full flow
Flywheel housing
Governor
  2301A, speed control
Lifting eyes
Manifold, exhaust, dry
Pumps,
  fuel transfer, gear driven
  lubricating oil –
    gear driven
  jacket water –
    gear driven
Rails, mounting
Shutoff, manual
Starting, electric, 24 Volt DC
Turbochargers
Vibration damper

Generator
SR4 brushless with VR3
  voltage regulator

ELECTRONIC MODULAR CONTROL PANEL (EMCP)

Standard Generator Controls and Monitoring:
Ammeter/voltmeter phase
  selector switch
Digital ammeter, voltmeter,
  and frequency meter
Voltage adjust rheostat

Standard Engine Controls and Monitoring:
Automatic/manual
  start-stop control
Engine control switch for:
  off/reset, auto start,
  manual start, stop,
  cooldown timer,
  cycle cranking,
  emergency stop
    pushbutton

Safety shutoff protection and LED indicators for:
High coolant temperature
Low oil pressure
Overcrank
Overspeed

OPTIONAL EQUIPMENT

Engine
Air cleaner, heavy duty
Charging alternator
Cooling systems
Exhaust fittings
Governor, Woodward
  3161, 2301A load
  share
Protection devices
Tachometer drive

Generator
Extension terminal box
Manual voltage control
Permanent magnet
  excitation
RFI Filters –
  N level (VDE 875),
    BS800
  MIL Std 461B
Space heater
Temperature rise
  detectors

Switchgear
Automatic start-stop
Battery charger
Circuit breaker
Manual
Electric operated

Switchgear
Enclosure — floor
  standing NEMA 1
Main load buss
Paralleling
  manual
  permissive
Protective relays

Control Panel
Annunciator panel and
  prealarm module
  (meets NFPA 99/110
  requirements)
Enclosure,
  NEMA 12/IP 23
Provision for:
  auxiliary relay
  charging voltmeter
  cycle cranking
  governor speed switch
  manual start-stop
    module
  prealarm module
  starting aid switch
  synchronizing lights

Caterpillar® EMCP II

Electronic Modular Control Panel

The Electronic Modular Control Panel (EMCP) is a generator-mounted control panel, available on all Caterpillar packaged generator sets. It utilizes environmentally sealed, solid-state, micrprocessor-based modules for engine control and AC metering. This new application of mature, high-tech electronics to generator monitoring provides more features, accuracy and reliability than present electro-mechanical and many competitive panel systems.

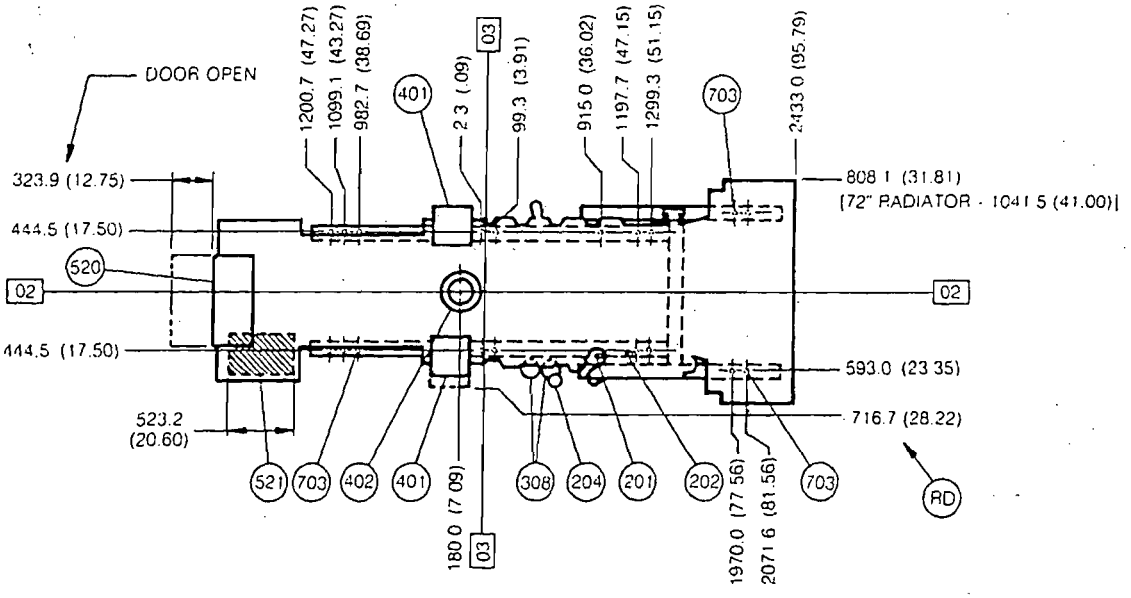
The EMCP provides these standard control and monitoring features, many of which are options on other panels:

- Automatic/manual start-stop engine control with programmable safety shutdowns and associated flashing LED indicators for low oil pressure, high coolant temperature, overspeed, overcrank and emergency stop
- Cycle cranking–adjustable 1-60 second crank/rest periods
- Cooldown timer–adjustable 0-30 minutes
- Energized to run or shutdown fuel control systems
- LCD digital readout for: Engine oil pressure; coolant temperature; engine rpm; system DC volts; engine running hours; system diagnostic codes; generator AC volts; generator AC amps; and generator frequency
- Engine control switch
- Ammeter-voltmeter phase selector switch
- Emergency stop pushbutton
- Indicator/display test switch
- Voltage adjust potentiometer

TECHNICAL DATA

3508 Prime Power Generator Sets			60 Hz–1800 RPM			
Rating Information	Power Rating @ 0.8 PF with Fan	kW	650	680	725	820
		kV•A	812	850	906	1025
	Engine Bhp without Fan		962	1014	1089	1220
Physical Factors	Length	mm	4471	4449	4449	4583
		in	176.0	175.2	175.2	180.4
	Width	mm	1703	1703	1703	2092
		in	67.0	67.0	67.0	82.4
	Height	mm	2361	2361	2361	2459
		in	93.0	93.0	93.0	96.8
	Weight	kg	7855	8210	8210	8490
		lb	17,320	18,100	18,100	18,720
	Generator Frame Size		589	681	681	685
Lubrication & Cooling Systems	Engine Lubricating Oil Capacity	L	227	227	227	227
		qts	240	240	240	240
	Engine Coolant Capacity with Radiator	L	225	225	225	280
		gal	59	59	59	75
	Standard Radiator Arrangement Data: Air Flow (Max @ Rated Speed)	m³/min	1178	1253	1432	1594
		cfm	41,595	44,243	50,564	56,284
	Air Flow Restriction (after radiator)	kPa	0.12	0.12	0.12	0.12
		in water	0.5	0.5	0.5	0.5
	Ambient Air Capability (TMI)	Deg. C	45	44	43	52
		Deg. F	113	111	110	126
	Radiator Size		60/13	60/13	60/13	72/25
Exhaust System	System Backpressure (Max Allowable)	kPa	6.7	6.7	6.7	6.7
		in water	27	27	27	27
	Exhaust Flange Size (Internal Diameter)	mm	203	203	203	203
		in	8.0	8.0	8.0	8.0
Performance Data @ Rated Conditions	Fuel Consumption (100% load) with Fan per ISO3046/1: +5%, -0% tolerance	L/Hr	183.7	192.8	208.2	233.9
		gph	48.5	50.9	55.0	61.8
	Fuel Consumption (75% load) with Fan	L/Hr	139.2	144.7	157.5	177.7
		gph	36.8	38.5	41.6	46.9
	Fuel Consumption (50% load) with Fan	L/Hr	98.9	102.7	110.7	124.4
		gph	26.1	27.2	29.2	32.9
	Combustion Air Inlet Flow Rate	m³/min	62.1	64.3	67.9	74.9
		cfm	2193	2270	2398	2645
	Exhaust Gas Flow Rate	m³/min	165	173	185	208
		cfm	5819	6091	6536	7362
	Heat Rejection to Coolant (total)	kW	441	463	501	566
		BTU/min	25,080	26,331	28,492	32,188
	Heat Rejection to Exhaust (total)	kW	750	790	857	981
		BTU/min	42,652	44,927	48,737	55,789
	Heat Rejection to Atmosphere from Engine	kW	103	104	106	109
		BTU/min	5858	5914	6028	6199
	Heat Rejection to Atmosphere from Generator	kW	45.9	48.1	52.9	48.6
		BTU/min	2610	2735	3010	2765
	Exhaust Gas Stack Temperature	Deg. C	515	523	536	552
		Deg. F	958	973	997	1026
	Deration for Engine Altitude–3% per 305m (1000 ft) above	m	2175	1675	950	725
		ft	7136	5495	3117	2379

PRIME GEN SET PACKAGE — TOP VIEW



02 Centerline of Engine	204 Fuel Filter	520 Control and Power Panel
03 Rear Face of Cylinder Block	308 Oil Filter	521 Conduit Entrance
201 Fuel Inlet	401 Air Inlet	703 Customer Mounting Holes
202 Excess Fuel Return	402 Exhaust	RD Removal Distance

For overall length see technical data section (page

Note: General configuration not to be used for installation. See general dimension drawings for detail.

CONDITIONS AND DEFINITIONS

Prime — Output available with varying load for an unlimited time. Prime power in accordance with ISO8528. 10% overload power in accordance with ISO3046/1, AS2789, DIN6271, and BS5514 available on request.

Standby — Output available with varying load for the duration of the interruption of the normal source power. Fuel stop power in accordance with ISO3046/1, AS2789, DIN6271, and BS5514.

Continuous — Output available without varying load for an unlimited time. Continuous power in accordance with ISO8528, ISO3046/1, AS2789, DIN6271 and

Ratings are based on SAE J1349 standard conditions. These ratings also apply at ISO3046/1, DIN6271 and BS5514 standard conditions.

Fuel rates are based on fuel oil of 35° API (16° C or 60° F) gravity having an LHV of 42 780 kJ/kg (18,390 Btu/lb) when used at 29° C (85° F) and weighing 838.9 g/L (7.001 lbs/U.S. gal.).

PANTROPIC POWER PRODUCTS, INC.

8205 N.W. 58th Street , Miami, FL 33166

FAX COVER

DATE: 10 – 20 - 00	FROM: Robert Butt . Project Manager
COMPANY: MIAMI DADE WASA	TEL. # (305) 592-4944 , ext 3108
ATTN : MR. RICHARD O'ROURKE	FAX # (305) – 574 - 7875
FAX # : (305 – 669 - 5749 TEL) Fax # 305-669-5717	REFERENCE : REQUEST FOR INFORMATION
PAGES : 3 (Including this page)	ALEXANDER ORR JR. WTP PROJECT GENERATOR EQUIPMENT

(PLEASE ADVISE IMMEDIATELY IF ALL PAGES ARE NOT RECEIVED)

Mr. O'Rourke :

Please find attached Caterpiliar factory issued technical information pertaining to the generator set engine exhaust emissions and fuel consumption data in response to your inquiry.
This information is specific to the generator set model that is to be furnished by Pantropic Power Products , Inc. for the above referenced Project.

Response: Date:

EMISSIONS

3508 DI TA JW DRY MANF TURBO QTY WDWRD GOV
TM4516-09 PGS STANDBY 60 HERTZ EXH STK DIA 8.0 IN
GEN 900.0 W/F EKW 930.0 W/O F EKW W/F BHP 1337 W/O F BHP @ 1800 RPM

INFO CODE 05 - EMISSIONS DATA * * REFERENCE NOTES - NOT TO EXCEED * * * * * * *
EMISSIONS DATA MEASUREMENT IS CONSISTENT WITH THOSE DESCRIBED IN EPA CFR 40 PART 86 SUBPART D AND ISO 8178-1 FOR MEASURING HC, CO, CO2 AND NOX. THESE PROCEDURES ARE VERY SIMILAR TO THE METHODS DESCRIBED IN EPA CFR 40 PART 60 APPENDIX A METHOD 25A FOR HYDROCARBONS, METHOD 10 FOR CO, METHOD 7E FOR NOX.

DATA SHOWN IS BASED ON STEADY STATE ENGINE OPERATING CONDITIONS OF 77 DEG F, 28.42 IN HG AND NUMBER 2 DIESEL FUEL WITH 35 DEG API AND LHV OF 18,390 BTU/LB.

TO PROPERLY APPLY THIS DATA YOU MUST REFER TO PERFORMANCE PARAMETER DM1176 FOR ADDITIONAL INFORMATION, (APPLICATION GKN402, PROGRAM 03).

3508 DI TA JW DRY MANF TURBO QTY WDWRD GOV
TM4516-09 PGS STANDBY 60 HERTZ EXH STK DIA 8.0 IN
GEN 900.0 W/F EKW 930.0 W/O F EKW W/F BHP 1337 W/O F BHP @ 1800 RPM

INFO CODE 05 - EMISSIONS DATA * * * * * RATED SPEED * * * * STANDARD TIMING
"NOT TO EXCEED DATA"

GEN PWR EKW	% LOAD	ENG PWR BHP	NOX (AS NO2) * * * * * * * *	CO	TOTAL HC LB/HR * * * * * * * *	PART MATTER	O2 (DRY) IN EXH (VOL) %	SMOKE OPAC %	BOSCH SMOKE NO.
900.0	100	1332.2	37.46	2.10	68	.310	9.90	1.0	1.28
675.0	75	1008.8	33.07	1.22	77	.250	11.40	0.9	1.28
450.0	50	690.9	25.67	.83	46	.190	12.40	1.0	1.28
225.0	25	378.9	16.92	.82	34	.150	13.50	1.0	1.28

3508 DI TA JW DRY MANF TURBO QTY WDWRD GOV
TM4516-09 PGS STANDBY 60 HERTZ EXH STK DIA 8.0 IN
GEN 900.0 W/F EKW 930.0 W/O F EKW W/F BHP 1337 W/O F BHP @ 1800 RPM

INFO CODE 05 - EMISSIONS DATA * * * * * RATED CONDITIONS * * STANDARD TIMING
"NOMINAL DATA"
AT RATED:

WET EXHAUST MASS	12838 LB/HR
WET EXHAUST FLOW (884 DEG F STACK TEMP)	7331 CFM
WET EXHAUST FLOW RATE (32 DEG F AND 29.98 IN HG)	2681 STD CFM
DRY EXHAUST FLOW RATE (32 DEG F AND 29.98 IN HG)	2473 STD CFM
FUEL FLOW RATE	66.0 GAL/HR

3508 DI TA JW DRY MANF TURBO QTY WDWRD GOV
TM4516-09 PGS STANDBY 60 HERTZ
GEN 900.0 W/F EKW 930.0 W/O F EKW W/F BHP 1337 W/O F BHP @ 1800 RPM
CERTIFICATION YEAR CERT AGENCY
INFO CODE 01 - GENERAL PERFORMANCE DATA *

GEN W/F EKW	PER CENT LOAD	ENG PWR BHP	ENG BMEP PSI	S FUEL CONSUM LB/BHP-HR	FUEL RATE GPH	INTAKE MANF T DEG F	INTAKE MANF P IN-HG	INTAKE AIR FL CFM	EXH MANF T DEG F	EXH STK T DEG F	EXH GAS FL CFM
900.0	100	1332	278	.350	66.5	214	78.3	2821	1262	884	7327
810.0	90	1202	251	.346	59.4	208	71.8	2691	1177	831	6695
720.0	80	1073	224	.344	52.8	203	64.5	2532	1103	787	6073
675.0	75	1009	211	.346	49.8	202	60.6	2436	1079	776	5787
630.0	70	945	197	.347	46.8	200	56.4	2334	1052	764	5484
540.0	60	817	171	.350	40.9	198	47.8	2112	1000	742	4866
450.0	50	691	144	.357	35.2	196	39.4	1886	952	723	4269
360.0	40	568	119	.368	29.9	195	31.2	1667	906	705	3708

3508 DI TA JW DRY MANF TURBO QTY WDWRD GOV
TM4516-09 PGS STANDBY 60 HERTZ
GEN 900.0 W/F EKW 930.0 W/O F EKW W/F BHP 1337 W/O F BHP @ 1800 RPM
CERTIFICATION YEAR CERT AGENCY
INFO CODE 01 - GENERAL PERFORMANCE DATA *

GEN W/F EKW	PER CENT LOAD	ENG PWR BHP	ENG BMEP PSI	S FUEL CONSUM LB/BHP-HR	FUEL RATE GPH	INTAKE MANF T DEG F	INTAKE MANF P IN-HG	INTAKE AIR FL CFM	EXH MANF T DEG F	EXH STK T DEG F	EXH GAS FL CFM
270.0	30	443	93	.386	24.4	193	23.0	1441	858	686	3157
225.0	25	379	79	.400	21.6	192	19.2	1335	827	670	2888
180.0	20	315	66	.420	18.9	191	16.2	1250	780	640	2638
90.0	10	184	38	.504	13.3	189	10.8	1098	670	564	2157

3508 DI TA JW DRY MANF TURBO QTY WDWRD GOV
TM4516-09 PGS STANDBY 60 HERTZ
GEN 900.0 W/F EKW 930.0 W/O F EKW W/F BHP 1337 W/O F BHP @ 1800 RPM

INFO CODE 02 - HEAT REJECTION DATA *

GEN W/F EKW	PER CENT LOAD	REJ TO JW BTU/MN	REJ TO ATMOS BTU/MN	REJ TO EXH BTU/MN	EXH RCOV TO 350F BTU/MN	FROM OIL CLR BTU/MN	FROM AFT CLR BTU/MN	WORK ENERGY BTU/MN	LHV ENERGY BTU/MN	HHV ENERGY BTU/MN
900.0	100	34804	8246	53116	28435	7621	11033	56472	142743	152070
810.0	90	31051	7166	46633	24227	6768	9327	50955	127559	135862
720.0	80	27639	6483	41231	20530	6028	7621	45496	113228	120621
675.0	75	26103	6199	38842	19222	5687	6824	42766	106915	113853
630.0	70	24511	5971	36454	17857	5346	5971	40036	100432	106972
540.0	60	21440	5573	31847	15241	4663	4322	34691	87750	93494
450.0	50	18483	5175	27525	12909	4038	2957	29288	75637	80585
360.0	40	15639	4777	23430	10805	3412	1763	24113	64035	68244

3508 DI TA JW DRY MANF TURBO QTY WDWRD GOV
TM4516-09 PGS STANDBY 60 HERTZ
GEN 900.0 W/F EKW 930.0 W/O F EKW W/F BHP 1337 W/O F BHP @ 1800 RPM

INFO CODE 02 - HEAT REJECTION DATA *

GEN W/F EKW	PER CENT LOAD	REJ TO JW BTU/MN	REJ TO ATMOS BTU/MN	REJ TO EXH BTU/MN	EXH RCOV TO 350F BTU/MN	FROM OIL CLR BTU/MN	FROM AFT CLR BTU/MN	WORK ENERGY BTU/MN	LHV ENERGY BTU/MN	HHV ENERGY BTU/MN

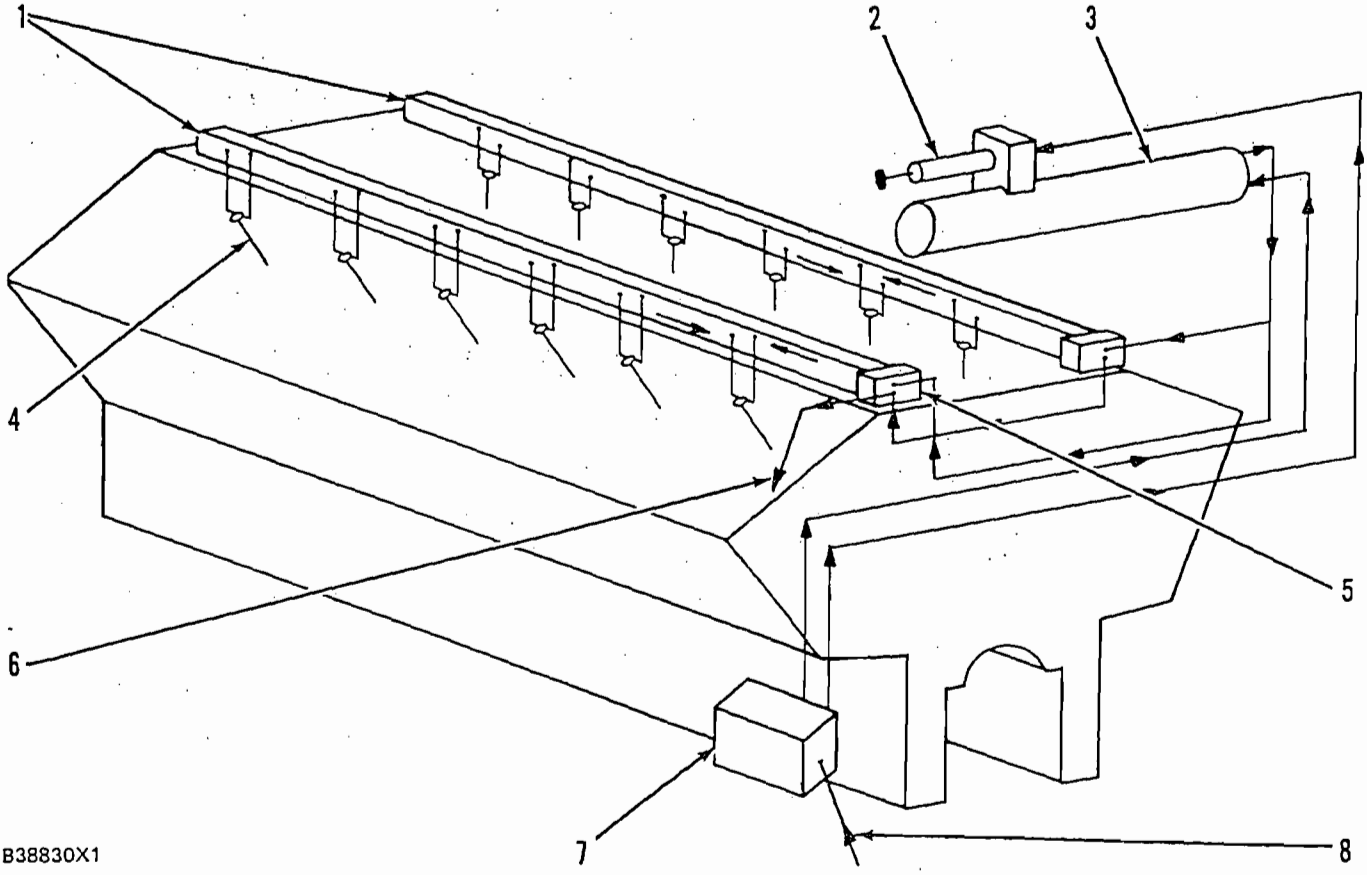
RANSMISSION VERIFICATION REPORT

TIME : 10/20/2000 11:03

DATE,TIME	10/20 11:01
FAX NO./NAME	3056695717
DURATION	00:01:14
PAGE(S)	03
RESULT	OK
MODE	FINE ECM

FUEL SYSTEM

GENERAL

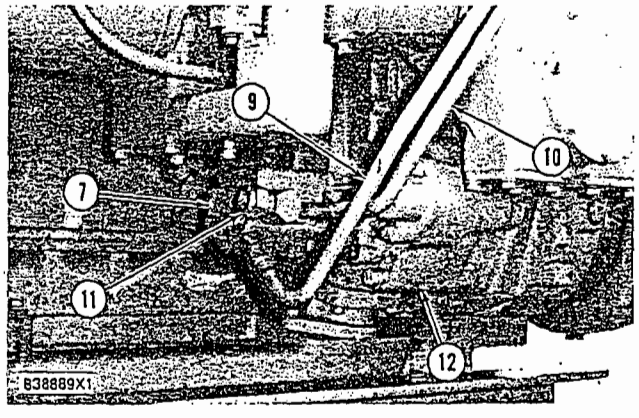


FUEL FLOW SCHEMATIC
(3512 Illustrated)

1. Fuel manifolds. 2. Fuel priming pump. 3. Fuel filter housing. 4. Fuel injectors. 5. Pressure regulating valve. 6. Fuel return to supply. 7. Fuel transfer pump. 8. Fuel from supply.

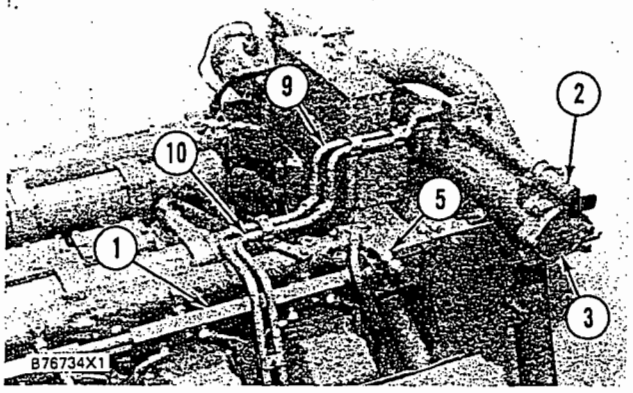
Fuel transfer pump (7) is located on the right side of the engine. The lower shaft of engine oil pump (12) drives the gear type transfer pump. Fuel from the supply tank is pulled through a primary fuel filter by the transfer pump and sent to the fuel filter housing.

The transfer pump has a check valve and a bypass valve. The check valve is located in the pump head assembly located behind where line (9) is connected. The check valve prevents fuel flow back through the transfer pump when priming pump (2) is used. The bypass valve is located behind a cap (plug) in the drive end of the pump. The bypass valve limits the maximum pressure of the fuel. It will open the outlet side of the pump to the pump inlet if the fuel pressure goes up to 860 kPa (125 psi). This helps prevent damage to fuel system components caused by too much pressure.



RIGHT SIDE OF ENGINE

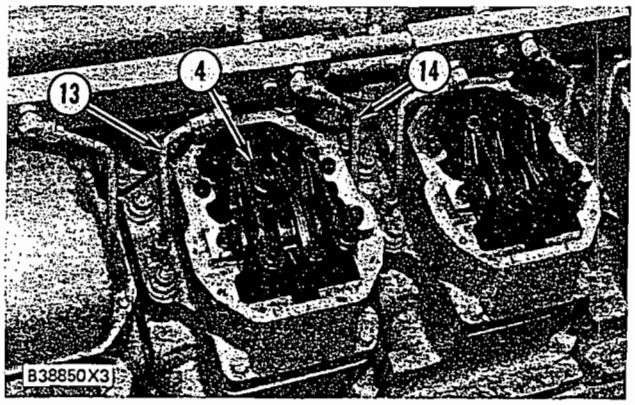
7. Fuel transfer pump. 9. Fuel line to filter housing. 10. Fuel line to priming pump. 11. Elbow (fuel supply). 12. Engine oil pump.



RIGHT SIDE OF ENGINE

1. Fuel manifold (right hand). 2. Priming pump. 3. Fuel filter housing. 5. Pressure regulating valve. 9. Fuel line to filter housing (from transfer pump). 10. Fuel line to priming pump (from transfer pump).

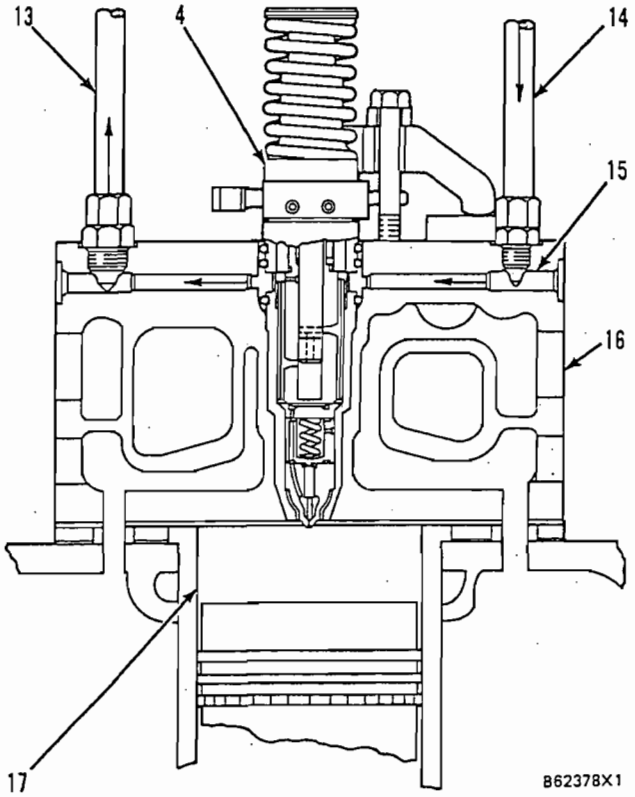
The transfer pump pushes fuel through fuel filter housing (3) to fuel manifolds (1). The fuel manifolds have two sections. The fuel flows through the top section of the manifold to inlet fuel line (14) connected to the right side of each cylinder head. On earlier engines, filter screens are located in the fittings where fuel goes into each cylinder head. On later engines, the filter screens are located in the ports of the unit injector. A drilled passage (15) in cylinder head (16) takes fuel to a circular (shape of a circle) chamber around the injector. The chamber is made by O-rings on the outside diameter of injector (4) and the injector bore in the cylinder head.



CYLINDER HEADS

4. Injector. 13. Outlet fuel line. 14. Inlet fuel line.

Only part of the fuel in the chamber is used for injection. Approximately 4 1/2 times as much fuel as needed for normal combustion flows through the chamber to a drilled passage in the left side of the cylinder head. This passage is connected by outlet fuel line (13) to the bottom section of the fuel manifold. This constant flow of fuel around the injectors helps to cool them.



FUEL FLOW THRU INJECTOR

4. Injector. 13. Outlet fuel line. 14. Inlet fuel line. 15. Drilled passage. 16. Cylinder head. 17. Cylinder.

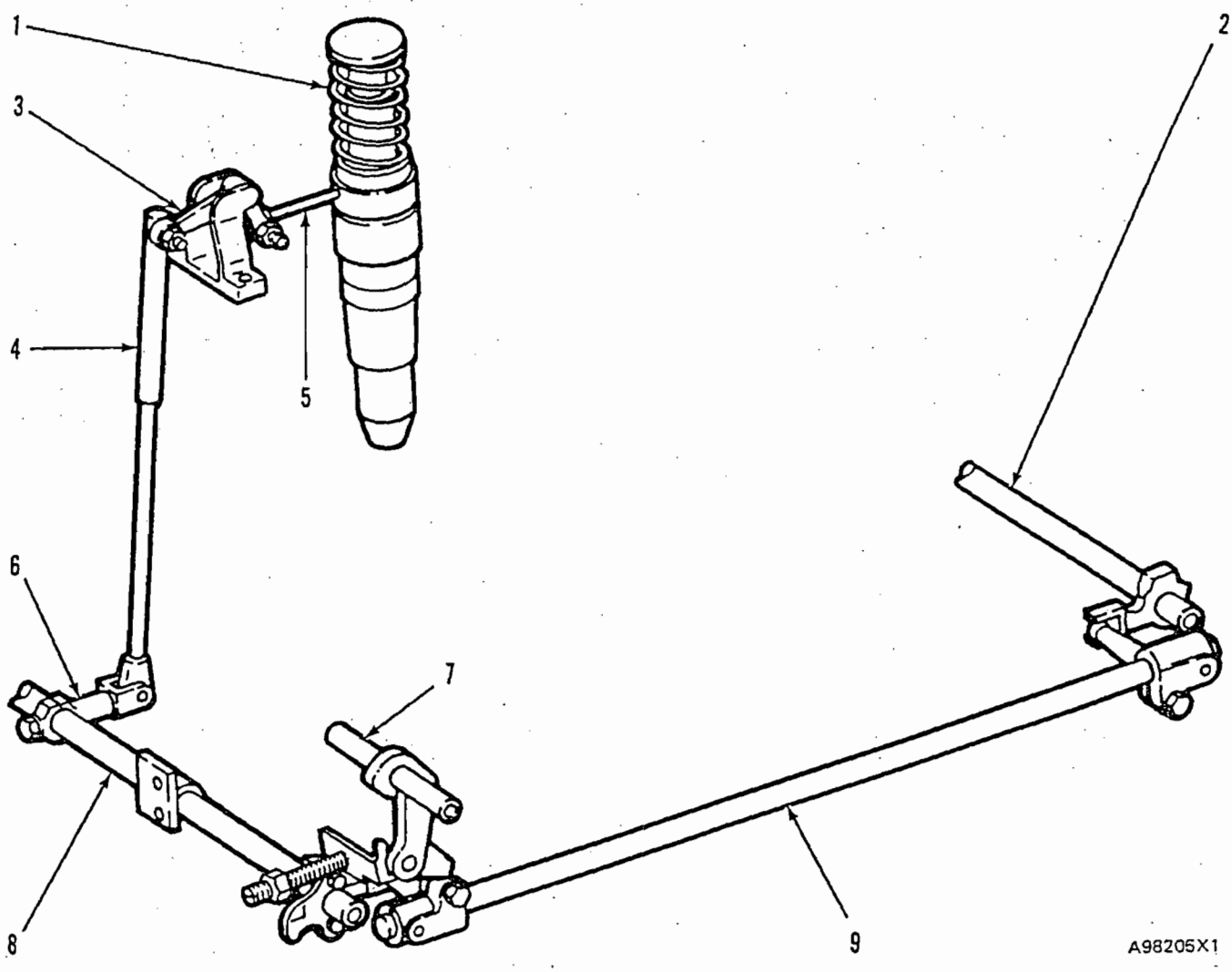
The fuel flows back through the bottom section of each fuel manifold to pressure regulating valve (5), on the front of the right fuel manifold. The fuel flows through this valve and then back to the tank.

Check each engine installation for an excess fuel flow based on fuel consumed (used for combustion). Minimum flow is three times the amount of fuel consumed. Excess fuel is then returned to the fuel tank, not back to the pump inlet. This will make sure that any air in the system will be removed before the fuel is sent back to the injectors.

Pressure regulating valve (5) has a spring and plunger arrangement between the bottom section of the fuel manifolds and the line that returns fuel to the tank. The valve keeps the pressure of the fuel between 415 to 450 kPa (60 to 65 psi).

A syphon break (small orifice) between the inlet and outlet passages in the regulator valve adapter is used when the filters are changed to remove the air from the system. Normally it will not be necessary to use priming pump (2) to force air from the system after the filters are changed. The priming pump must be used when the lines are dry. For example: af[illegible] overhaul or other major fuel system work.

FUEL INJECTION CONTROL LINKAGE



FUEL INJECTOR CONTROL LINKAGE

1. Injector. 2. Control shaft (left side). 3. Bellcrank. 4. Control rod. 5. Rack. 6. Lever. 7. Governor shaft. 8. Control shaft (right side). 9. Cross shaft.

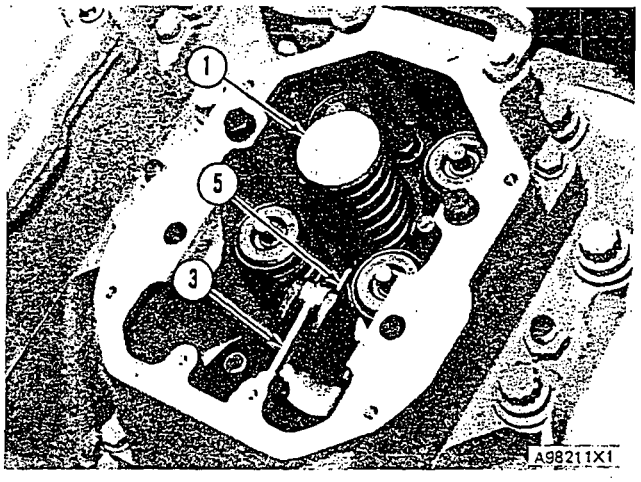
A fuel injector (1) is located in each cylinder head. The position of rack (5) controls the amount of fuel injected into the cylinder. Pull the rack out of the injector for more fuel, push it in for less fuel.

Rack position is changed by bellcrank (3). The bellcrank is moved by control rod (4). The control rods have an adjustment screw on the top. The adjustment screw is used to synchronize the injectors. The control rods are spring loaded. If the rack of one injector sticks (will not move), it will still be possible for the governor to control the other racks so the engine can be shutdown. Each control rod on the right side of the engine is connected by a lever (6) to control shaft (8).

When the rotation of governor shaft (7) is clockwise, as seen from in front of the engine, the action of the governor linkage moves control shaft (8) counterclockwise. That is, in the fuel "ON" direction.

Right control shaft (8) and left control shaft (2) are connected by cross shaft (9). The linkage between the injectors on the left side of the engine and control shaft (2) is similar to the linkage on the right side.

Should the linkage become disconnected from the governor, the weight of the control linkage will move the fuel injector racks to the fuel "SHUTOFF" position, and the engine will stop.



CYLINDER HEAD
(Rocker Shaft Removed for Photo Illustration)
1. Injector. 3. Bellcrank. 5. Rack.

FUEL INJECTOR

The injector is held in position by clamp (3). Fuel is injected when rocker arm (2) pushes the top of the injector down. The movement of the rocker arm is controlled by the camshaft through lifter assembly (7) and push rod (4). The amount of fuel injected is controlled by rack (5). Movement of the rack causes rotation of a gear fastened to plunger (6). Rotation of the plunger changes the effective stroke (that part of the stroke during which fuel is actually injected) of the plunger.

Injection timing is a product of two factors; the angular location of camshaft (8) and the location of plunger (6). The angular location of the camshaft is controlled by the camshaft drive gears at the rear of the engine. The location of the plunger can be adjusted with screw (1).

Injection Cycle

When the plunger is at the top of its stroke, fuel flows from the fuel supply chamber, around the injector and through both the lower and upper ports of the barrel. As plunger (6) is moved down by rocker arm (2), fuel is pushed back into the supply chamber through the lower port. The fuel can now go up through a passage in the center of the plunger and out through the upper port of the barrel. As the lower port is closed by the lower scroll on plunger (6), fuel can still flow through the upper port until it is closed by the upper scroll on plunger (6). At this point, injection starts and the effective stroke begins. During the effective stroke, fuel is injected into the cylinder until the downward movement of plunger (6) causes the lower scroll to open the lower port and release the fuel pressure.

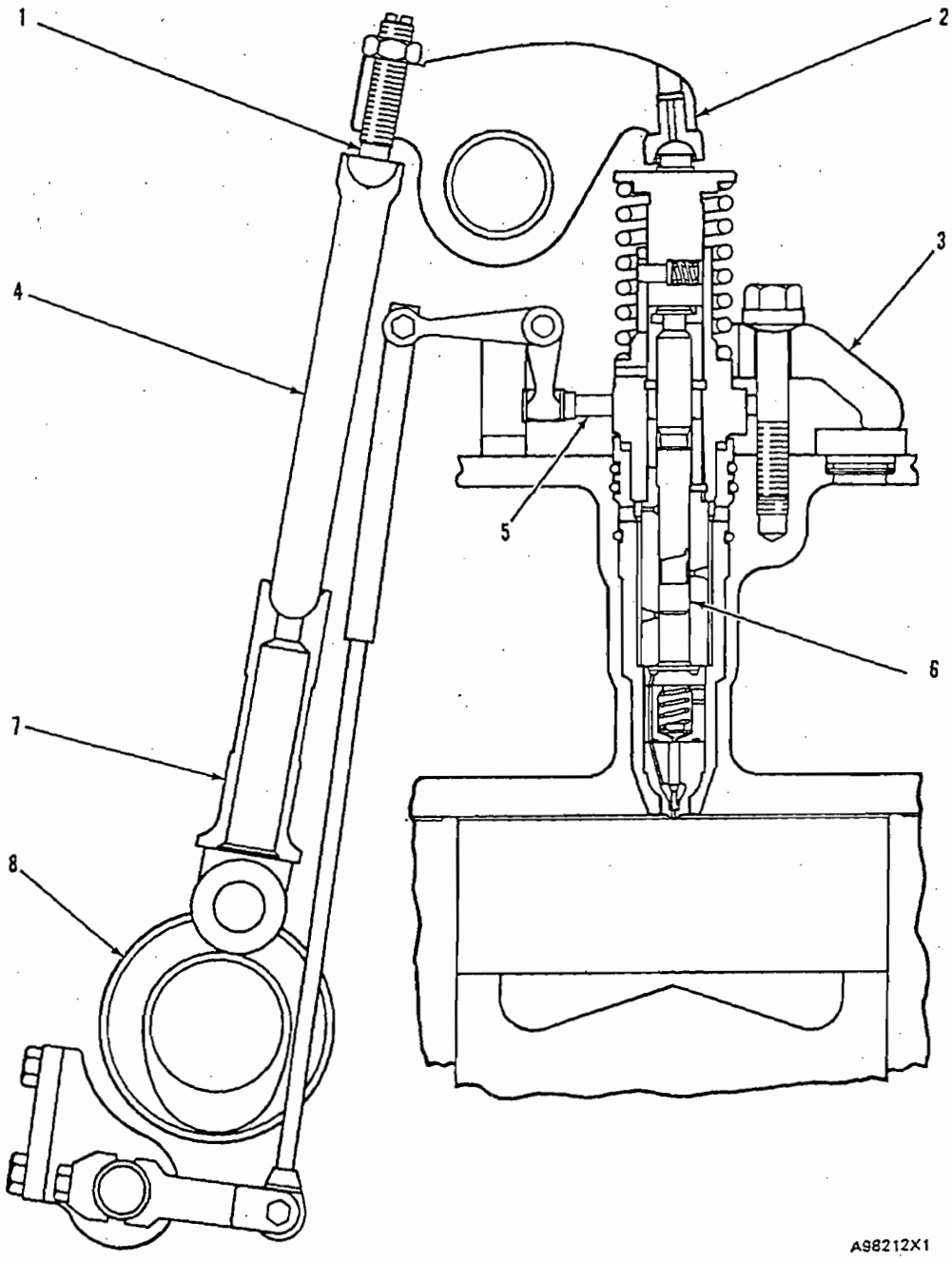
Fuel then goes through the center passage of plunger (6) and the lower port during the remainder of the downstroke. This sudden release of pressure when the lower port is opened causes the fuel to hit the spill deflector with a high force. The spill deflector gives protection to the injector housing (nut) from erosion (wear) because of the force of the released fuel. On the return (UP) stroke, the chamber inside the injector barrel is filled with fuel again.

The plunger can be turned by rack (5) at the same time it is moved up and down by rocker arm (2). The upper section of the plunger has a flat side that fits in the gear, which is engaged with the rack. The plunger slides up and down in the gear, which also has a flat side on its inside diameter. The flat sides let the parts turn together. The rack is engaged with the gear. When the rack moves, it turns the plunger through the gear. The rotation of plunger (6) controls injection timing and the fuel output of the injector. Rotation of the plunger changes the relation of the plunger scrolls to the ports in the barrel, and this increases or decreases the length of the effective stroke and the point at which injection takes place.

When rack (5) is moved all the way in against the injector body, no injection takes place during the downstroke of the plunger. This is the fuel "SHUTOFF" position. A small amount of rack movement "OUT" from the injector body is used as a "NO FUEL" movement or "SHUTOFF" position for governing purposes. This "NO FUEL" distance starts at the "ALL-THE-WAY-IN" position of the rack, and ends when the lower scroll opens the lower port and the upper scroll closes the upper port. Movement of the rack "OUT" from this point in the fuel "ON" direction, gives an interval in the plunger stroke when both ports are closed by the scrolls and injection takes place. As the rack is moved farther "OUT" in the fuel "ON" direction, the quantity of fuel during the injection stroke increases until a maximum is available at full rack movement.

The scrolls on plunger (6) are used to time the start of injection and set the amount of fuel per injection stroke. The scrolls can change the start of injection in relation to the engine piston position and the length of the effective stroke in relation to the different engine loads. The start of injection can be retarded (made later) with a decrease or increase in injector output according to the engine needs.

During the fuel injection stroke, fuel passes from the barrel chamber through a valve assembly. The valve assembly has a spring-loaded needle valve with a cone shaped end which operates against a seat. The angle of the valve is slightly larger than that of the



FUEL INJECTOR OPERATION

1. Screw. 2. Rocker arm. 3. Clamp. 4. Control rod. 5. Rack. 6. Plunger. 7. Lifter assembly. 8. Camshaft.

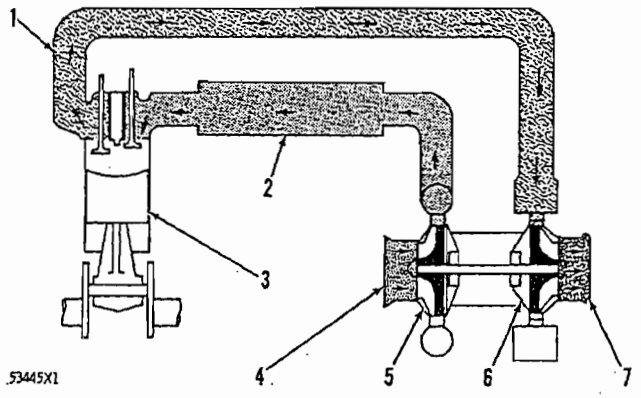
seat to give line contact. The valve opens at approximately 20 000 to 23 300 kPa (2800 to 3400 psi) and closes at approximately 10 300 kPa (1500 psi). The fuel flows from the chamber inside the barrel through drilled passages and grooves in the spring cage, and then through passages around the guide section of the valve to the valve chamber. Here the fuel pressure lifts the needle valve off its seat, and the fuel now flows through the spray tip and out the orifices into the combustion chamber.

A flat check valve is used above the needle valve to keep the high pressure combustion gases out of the injector. If the needle valve is held open by small foreign particles for a moment between injection cycles, combustion gases can come into the injector and cause damage. The injector operates with the flat check valve until the foreign particle has washed on through and normal operation takes place.

The spray tip of the injector extends a short distance below the cylinder head into the combustion chamber. The spray tip has several small orifices spaced evenly around the outside diameter. The tip sprays fuel into the combustion chamber. The top surface of the piston has a shaped (mexican hat-type) crater. The design of the piston causes rotation of the air as it comes through the valves into the combustion chamber, which improves the mixture of the fuel and air.

AIR INLET AND EXHAUST SYSTEM

The components of the air inlet and exhaust system control the quality and amount of air available for combustion. There is a separate turbocharger and exhaust manifold on each side of the engine. A common aftercooler is located between the cylinder heads in the center of the engine. The inlet manifold is a series of elbows that connect the aftercooler chamber to the inlet ports (passages) of the cylinder heads. Two camshafts, one in each side of the block, control the movement of the valve system components.



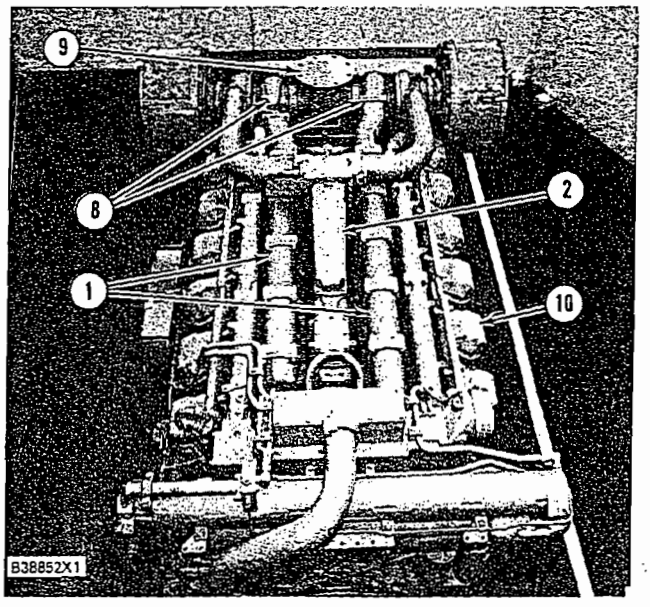
AIR INLET AND EXHAUST SYSTEM

1. Exhaust manifold. 2. Aftercooler. 3. Engine cylinder. 4. Air inlet. 5. Turbocharger compressor wheel. 6. Turbocharger turbine wheel. 7. Exhaust outlet.

Air flow is the same on both sides of the engine. Clean inlet air from the air cleaners is pulled through air inlet (4) by compressor wheel (5). The rotation of the compressor wheel causes compression of the air and forces it through a tube to aftercooler (2). The aftercooler lowers the temperature of the compressed air before it goes into the inlet chambers in each cylinder head. This cooled, compressed air fills the inlet chambers in the cylinder heads. Air flow from the inlet chamber into the cylinder is controlled by the intake valves.

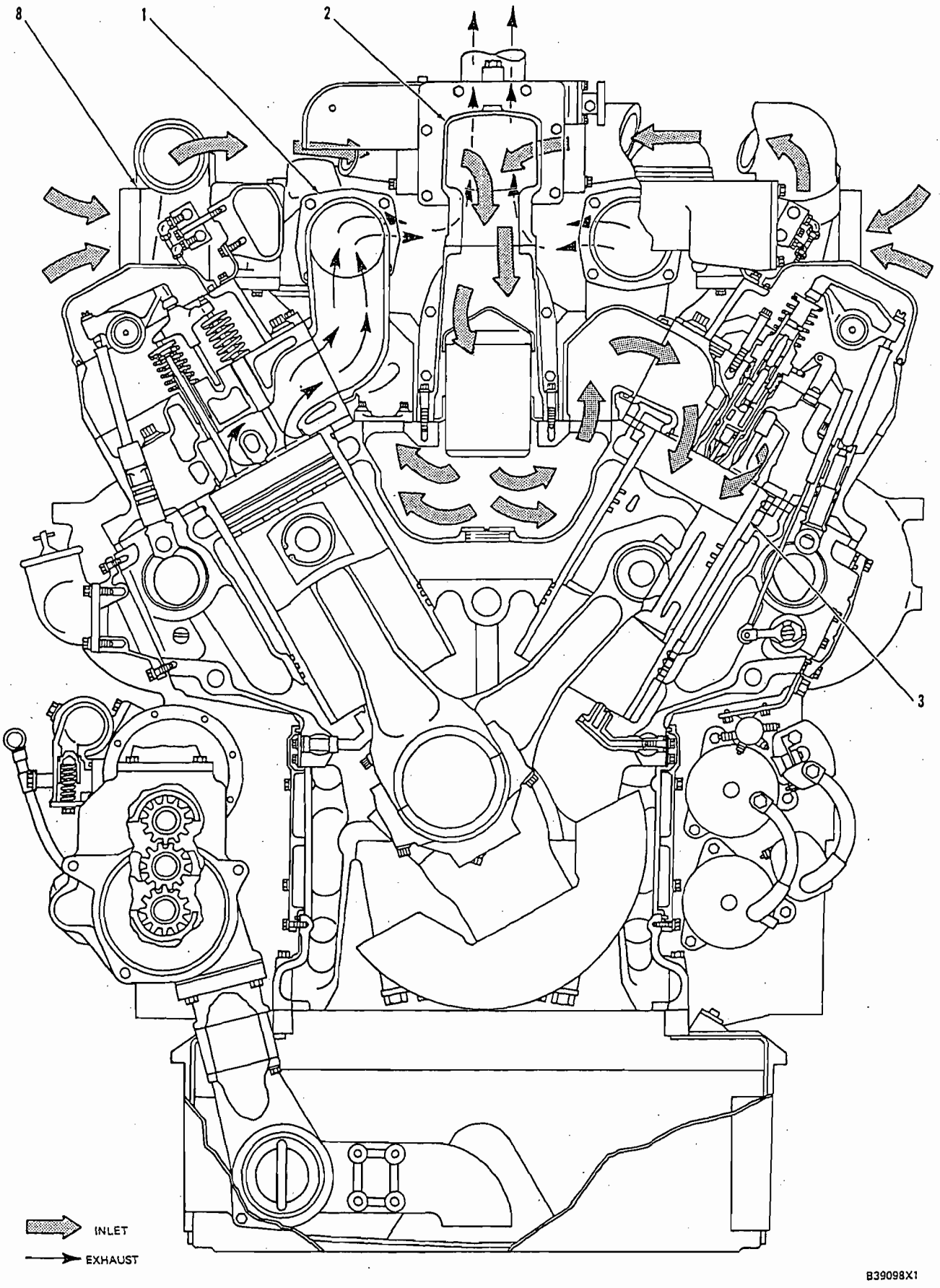
There are two intake and two exhaust valves for each cylinder. Make reference to Valve System Components. The intake valves open when the piston moves down on the inlet stroke. Cooled, compressed air from the inlet chamber is pulled into the cylinder. The intake valves close and the piston starts to move up on the compression stroke. When the piston is near the top of the compression stroke, fuel is injected into the cylinder. The fuel mixes with the air and combustion starts. The force of combustion pushes the piston down on the power stroke. When the piston moves up again it is on the exhaust stroke. The exhaust valves open and the exhaust gases are pushed through the exhaust port into exhaust manifold (1). After the piston makes the exhaust stroke, the exhaust valves close and the cycle (inlet, compression, power, exhaust) starts again.

Exhaust gases from the exhaust manifold go into the turbine side of the turbocharger (8) and cause turbine wheel (6) to turn. The turbine wheel is connected to the shaft that drives compressor wheel (5). The exhaust gases then go out the exhaust outlet (7) through exhaust elbow (9).



AIR SYSTEM COMPONENTS
(3512 Engine Shown)

1. Exhaust manifolds. 2. Aftercooler. 8. Turbochargers. 9. Exhaust elbow. 10. Cylinder head.



AIR FLOW SCHEMATIC

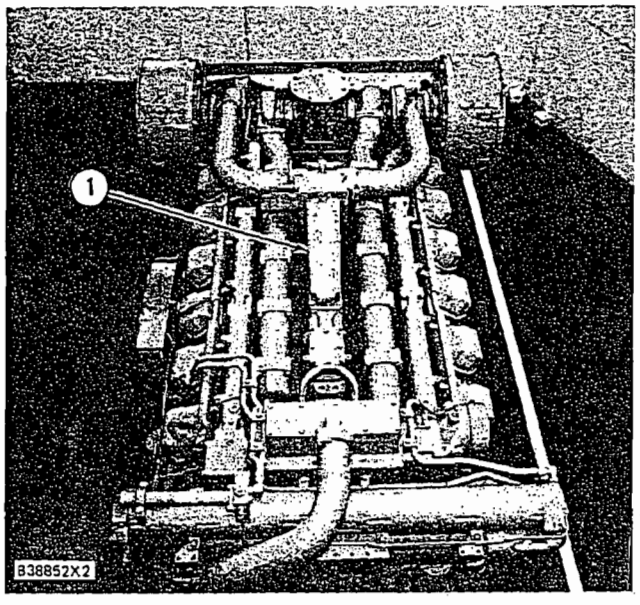
1. Exhaust manifold. 2. Aftercooler. 3. Cylinder. 8. Turbocharger.

AFTERCOOLER

The aftercooler is located at the center of the vee, and has a coolant charged core assembly. The 3516 can have two core assemblies. Coolant from water pump (3) flows through pipe (2) into the aftercooler. It then flows through the core assembly (assemblies) and back out of the aftercooler through a different pipe into the rear of the cylinder block.

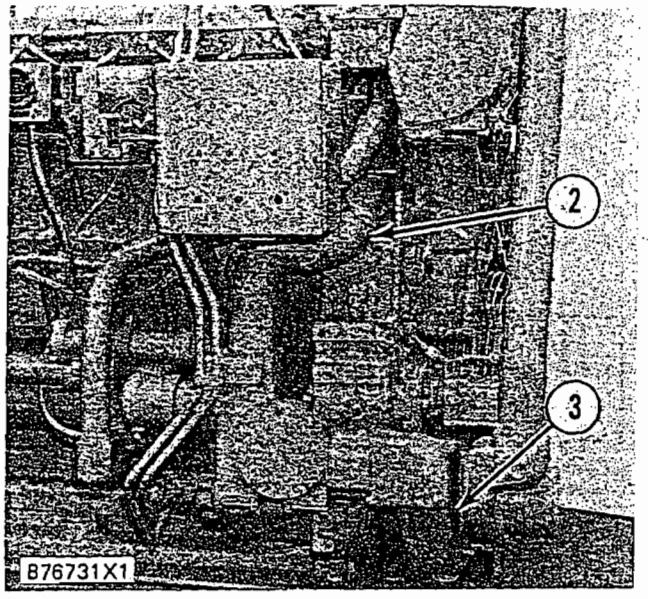
There is a connector (tube) that connects the bottom rear of each core assembly to the cylinder block. This is used to drain the core assembly (assemblies) when the coolant is drained from the engine.

Inlet air from the compressor side of the turbochargers flows into the aftercooler through pipes. This air then passes through the fins of the core assembly (assemblies) which lowers the temperature. The cooler air goes out the bottom of the aftercooler into the air chamber, and then up through the elbows to the inlet ports (passages) in the cylinder heads.



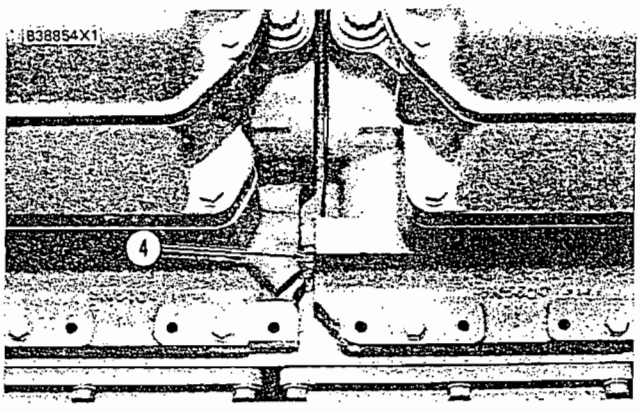
TOP OF ENGINE

1. Aftercooler housing.



RIGHT FRONT OF ENGINE

2. Pipe. 3. Water pump.



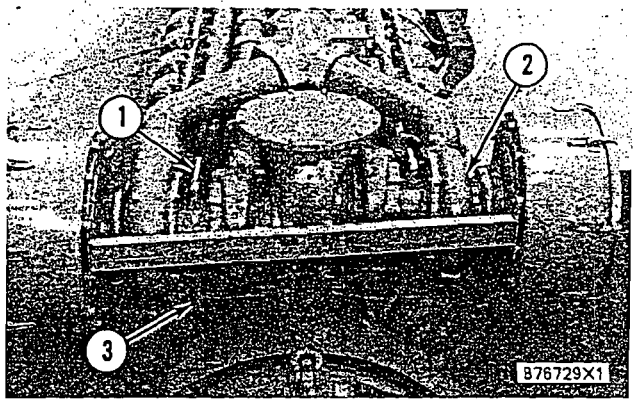
AFTERCOOLER AIR CHAMBER DRAIN

4. Drain plug.

One drain plug is located between the No. 1 and No. 3 cylinder heads, and another plug is located between the last two cylinder heads on the left side of the engine. These plugs can be removed to check for water or coolant in the aftercooler air chamber.

TURBOCHARGERS

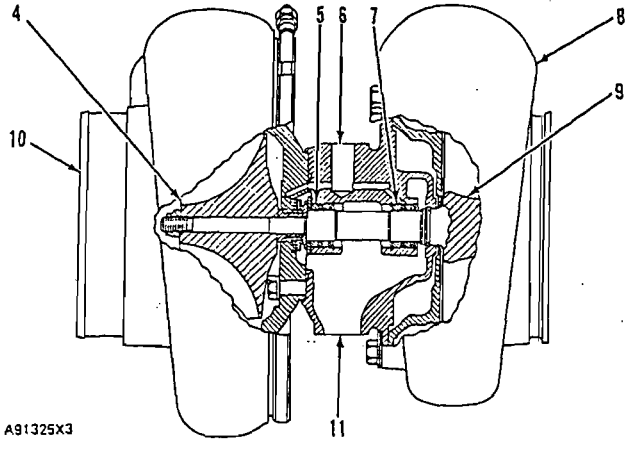
There are two turbochargers, on the rear of the engine. The turbine side of the turbochargers is fastened to the exhaust manifolds. The compressor side of the turbocharger is connected to the aftercooler.



TURBOCHARGERS

1. Oil supply line. 2. Turbocharger. 3. Oil drain line.

The exhaust gases go into turbine housing (8) and push the blades of turbine wheel (9). This causes the turbine wheel and compressor wheel to turn at up to 70,000 rpm.



TURBOCHARGER
(3512 SHOWN)

4. Compressor wheel. 5. Bearing. 6. Oil inlet. 7. Bearing. 8. Turbine housing. 9. Turbine wheel. 10. Air inlet. 11. Oil outlet.

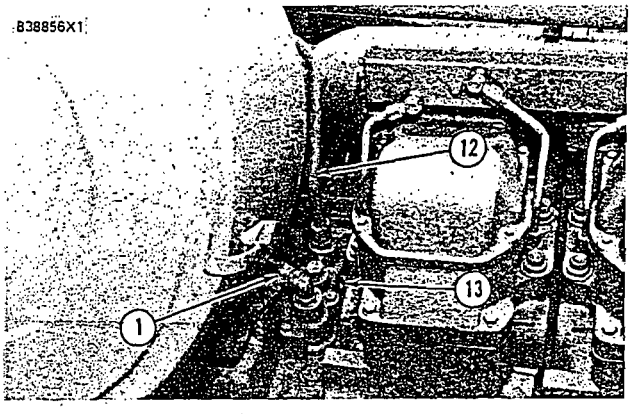
Clean air from the air cleaners is pulled throu the compressor housing air inlet (10) by rotation compressor wheel (4). The action of the comp wheel blades causes a compression of the inle This compression gives the engine more power b cause it makes it possible for the engine to bu additional fuel with greater efficiency.

Maximum rpm of the turbocharger is controlle by the fuel setting, the high idle rpm setting and th height above sea level at which the engine operated.

NOTICE

If the high idle rpm or the fuel setting is highe than given in the Fuel Setting Information (fo the height above sea level at which the engine is operated), there can be damage to engine o turbocharger parts. Damage will result when increased heat and/or friction, due to the higher engine output, goes beyond the engine cooling and lubrication systems abilities. A mechanic that has the proper training is the only one to make the adjustment of fuel setting and high idle rpm setting.

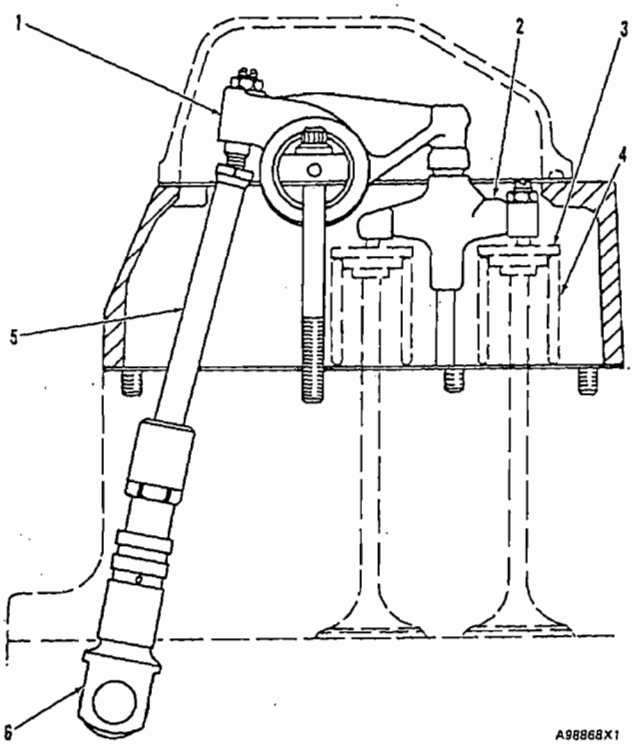
The bearings (5 and 7) in the turbocharge engine oil under pressure for lubrication. The oil comes in through oil inlet port (6) and goes through passages in the center section for lubrication of the bearings. Then the oil goes out oil outlet port (11) and back to the oil pan.



TURBOCHARGER OIL LINES

1. Oil supply line to left turbocharger. 12. Oil supply line to right turbocharger. 13. Oil manifold.

VALVE SYSTEM COMPONENTS



VALVE SYSTEM COMPONENTS

1. Rocker arm. 2. Bridge. 3. Rotocoil. 4. Valve spring. 5. Push rod. 6. Lifter.

The valve system components control the flow of inlet air and exhaust gases into and out of the cylinders during engine operation.

The crankshaft gear drives the camshaft gears through idlers. Both camshafts must be timed to the crankshaft to get the correct relation between piston and valve movement.

The camshafts have three cam lobes for each cylinder. Two lobes operate the valves and one operates the fuel injector.

As each camshaft turns the lobes of the camshafts, they cause lifters (6) to go up and down. This movement makes push rods (5) move the rocker arms (1). Movement of the rocker arms makes the bridges (2) move up and down on dowels in the cylinder head. The bridges allow one rocker arm to open or close two valves (intake or exhaust) at the same time. There are two intake and two exhaust valves for each cylinder.

Rotocoils (3) cause the valves to turn while the engine is running. The rotation of the valves keeps the deposit of carbon on the valves to a minimum and gives the valves longer service life.

Valve springs (4) cause the valves to close when the lifters move down.