



**PSEG**

**REGULATORY DOCKET FILE COPY**

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January 19, 1978

Director of Nuclear Reactor Regulation  
U. S. Nuclear Regulatory Commission  
Washington, D. C. 20555



Gentlemen,

Attached is the completed questionnaire on diesel generators. Mr. Richard A. Silverio, Assistant to Manager - Salem Generating Station, was responsible for completing this questionnaire. Any follow-up communications concerning this questionnaire or for arranging a site visit, should be directed to Mr. Herbert J. Heller, Manager - Salem Generating Station, P. O. Box 168, Hancocks Bridge, New Jersey 08038, (609) 365-7000, Extension 501.

Very truly yours,

F. P. Librizzi  
General Manager -  
Electric Production

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HEAD TO  
HEAD

The Energy People



**ENGINE MAINTENANCE SCHEDULE**  
**MARINE, STATIONARY AND DRILL RIG ENGINES**

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## ENGINE MAINTENANCE SCHEDULE

### MARINE, STATIONARY AND DRILL RIG ENGINES

## INTRODUCTION

The following schedule lists recommendations for maintaining marine, stationary and drill rig engines.

The maintenance groups in this guide, which fall due prior to expiration of the warranty contract, contain the minimum work necessary for reliable operation of the equipment. Adherence to these recommendations protects the equipment warranty.

Adjustment of the suggested maintenance intervals (as shown in this guide) to fit prevailing operating conditions is the responsibility of the user. Alco service representatives will assist customers in developing

suitable intervals for specific service conditions.

At the time of removal and replacement of any engine component, only new seals, gaskets or grommets should be used.

Refer to "Lubricant Specifications" publication for descriptions of lubricants listed.

Auxiliary equipment and instrumentation may vary. Disregard references to maintenance and inspection of equipment not applied. Any unlisted equipment should be serviced as frequently as comparable items listed.

## SCHEDULES

### SCHEDULE KEY & ITEM

### RECOMMENDATION

#### MAINTENANCE GROUP H - HOURLY

(H) Compressed Air System	Record starting air pressure reading.
(H) Cooling Water System	Record jacket water temperature reading. Record jacket water pressure reading.
(H) Diesel Engine	<u>Record temperature readings:</u> Air inlet Exhaust  Record air manifold pressure reading.  <u>Record readings:</u> RPM Fuel pump rack Load

**SCHEDULE KEY & ITEM****RECOMMENDATION**

- |                            |                                                                                         |
|----------------------------|-----------------------------------------------------------------------------------------|
| (H) Fuel Oil System        | Record fuel oil pressure reading.<br>Turn fuel strainer handle several turns.           |
| (H) Lubricating Oil System | Record lubricating oil temperature reading.<br>Record lubricating oil pressure reading. |

**MAINTENANCE GROUP D - DAILY**

- |                            |                                                                                                                                                          |
|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| (D) Diesel Engine          | Check governor oil and add as necessary (Lube Type 2).                                                                                                   |
| (D) Lubricating Oil System | Check system for level, temperature and leaks. Correct as required (Lube Spec. 5).<br>Check and record differential pressure across filter and strainer. |
| (D) Fuel Oil System        | Check system for level and leaks. Correct as required.                                                                                                   |
| (D) Cooling Water System   | Check system for level, temperature and leaks; correct as required. Check "tell tale" pipes on aftercooler and pumps.                                    |

NOTE: All items in hourly (Group H) schedule apply.

**MAINTENANCE GROUP W - WEEKLY**

- |                            |                                                                                                                                                                                                                           |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| (W) Cooling Water System   | Adjust gland on raw water pump if used to maintain slight drip while engine is operating.<br>Check coolant sample for proper concentration of water treatment. Refer to "Water Treatment" publication as listed in index. |
| (W) Lubricating Oil System | Check for proper lubricating oil properties (Lube Spec. 5).                                                                                                                                                               |
| (W) Compressed Air System  | Check oil level in air starting motor lubricator and fill if required (Lube Spec. 5).                                                                                                                                     |

NOTE: All items in hourly (Group H) and daily (Group D) schedules apply.

## SCHEDULE KEY &amp; ITEM

## RECOMMENDATION

## MAINTENANCE GROUP M - MONTHLY (OR 700 HOURS)

(M) Diesel Engine

Remove all fuel injection pump covers and thoroughly lubricate control shaft bearings, linkage and racks. Inspect and lubricate external linkage (Lube Spec. 1).

Check engine overspeed device trip speed, and adjust if necessary.

Check crankshaft deflection and thrust (if readings taken are correct after the first month or 700 hours, this inspection may be extended to semi-annual (6M) or 4250 hours).

Check and record cylinder compression and firing pressures.

Make complete crankcase inspection.

Clean and service engine air filters as indicated for type used.

Oil bath type: Check oil level and refill if required (Lube Spec. 5). If level has risen due to water ingress, drain and refill with fresh oil.

NOTE: Loss of oil may indicate oil is being drawn into engine. Correct this condition immediately if found.

Impingement Type: Clean and service.

Pleated paper type: Check filter indicator and replace elements if necessary.

(M) Lubricating Oil System

Renew filters and clean strainer.

Check operation of low oil pressure protective device.

(M) Fuel Oil System

Renew secondary filter elements.

Renew primary filter elements and clean strainer, if used.

Check condition of fuel pump drive, (shaft and coupling or belt) adjust belt tension if required.

SCHEDULE KEY & ITEM	RECOMMENDATION
(M) Cooling Water System	Check operation of hot engine protective device.
(M) Compressed Air System	Inspect air starting motor, lubricator and drive.  Inspect compressor; service in accordance with manufacturer's instructions.
*(M) Heat Exchanger	Inspect heat exchanger; clean if necessary.

NOTE: All items in hourly (Group H), daily (Group D) and weekly (Group W) schedules apply.

#### MAINTENANCE GROUP 3M - QUARTERLY (OR 2,100 HOURS)

(3M) Diesel Engine	Clean top deck and remove valve covers. Inspect mechanism, check and adjust valve clearance (0.035" - 0.86 mm).
(3M) Lubricating Oil	Drain and refill lube oil system. Examine sump, filter, and strainer tanks, and clean if required (Lube Spec. 5).  <u>NOTE:</u> Lubricating oil with over 700 hours of service, which has been in the engine for one year must be changed. Oil with less than 700 hours of service in one year should be qualified for further service by monthly samples analyzed by a reliable laboratory, but service life should not be allowed to exceed 700 hours.  Check operation of immersion heaters (if used). Check that contactor cuts in and out at proper temperatures.
(3M) Fuel Oil System	Drain condensate from fuel tanks.
(3M) Cooling Water System	Check operation of immersion heaters (if used). Check that contactor cuts in and out at proper temperatures.

NOTE: All items in hourly (Group H), daily (Group D), weekly (Group W) and monthly (Group M) schedules apply.

#### MAINTENANCE GROUP 6M - SEMI-ANNUALLY (OR 4,200 HOURS)

(6M) Diesel Engine	Check and adjust fuel pump timing.
--------------------	------------------------------------

**SCHEDULE KEY & ITEM****RECOMMENDATION**

(6M) Diesel Engine (Cont'd.)

Check and adjust uniformity of rack settings.

Check tightness of engine holddown bolts.  
(Also generator where necessary.)

Clean and service engine air filters as indicated for type used.

Oil bath type: Check for sludge buildup.  
Drain, wash and refill with lubricant  
(Lube Spec. 5).

(6M) Compressed Air System

Clean and lubricate starter motor Bendix drive.

\*(6M) Heat Exchanger

Check zinc anode plates or plugs if used. Inspect and replace if necessary.

NOTE: All items in hourly (Group H), daily (Group D), weekly (Group W), monthly (Group M) and quarterly (Group 3M) schedules apply.**MAINTENANCE GROUP 1A - ANNUALLY (OR 8,500 HOURS)**

(1A) Diesel Engine

Remove, recondition, test and reapply injection nozzles.

Service crankcase exhauster.Motor-driven type: Remove and clean housing, impeller and piping.Ejector (orifice type): Remove and clean chamber, orifice plate and piping.Turbo actuated type: Remove and clean piping and oil separator.

Drain, flush with kerosene, and refill engine governor with oil (Lube Spec. 2; Spec. 5 permissible in PG governor).

Inspect governor drive, gear backlash, and adjust.

Inspect turbocharger and air intake silencer for cleanliness.

**SCHEDULE KEY & ITEM****RECOMMENDATION**

(1A) Diesel Engine (Cont'd.)	Inspect air side of aftercooler. Remove clean and hydrostatically test if necessary.
	Inspect water pump drive gears and check gear backlash.
	Inspect lube oil pump drive gears and check gear backlash.
(1A) Compressed Air System	Flush out starting air motor with fuel oil (approx. 4 oz. of fuel).
(1A) Lubricating Oil System	Clean lube oil heat exchanger.
(1A) Operational Check	Inspect all rotating and/or running equipment for any unusual noise, heat or odor, as well as operating temperatures and pressures at full rated load.
(1A) Instruments and Gauges	<u>Check operation and recalibrate as required the following instruments and gauges.</u>
	Starting air pressure gauge
	Jacket water pressure gauge
	Air manifold pressure gauge
	Fuel oil pressure gauge
	Lubricating oil pressure gauge
	Jacket water inlet temperature gauge
	Jacket water outlet temperature gauge
	Jacket water lube oil cooler outlet temperature gauge
	Lubricating oil temperature gauge
	Lube oil cooler inlet temperature gauge
	Lube oil cooler outlet temperature gauge
	Tachometer
	Pyrometer

**NOTE:** All items in hourly (Group H), daily (Group D), weekly (Group W), monthly (Group M), quarterly (Group 3M) and semi-annually (Group 6M) schedules apply.



## SCHEDULE KEY &amp; ITEM

## RECOMMENDATION

## MAINTENANCE GROUP 3A - THREE YEARS (OR 25,000 HOURS)

(3A) Diesel Engine

Remove, recondition and reapply the following parts or assemblies:

Water pumps

Turbocharger

Cylinder heads with valves

Power assemblies

Fuel pump drives

Fuel injection pumps

Engine governor

Crankcase exhauster

Lube oil pump

Inspect the following parts:

Exhaust manifold

Camshaft and camshaft gear train

Camshaft thrust and vibration dampers,  
if usedCrankshaft and lower main bearing shells.  
Camshaft journals, thrust collars and  
thrust surfaces

Overspeed mechanism

Tachometer

(3A) Lubricating Oil System

Renew hoses and couplings used in system.

Clean lube oil cooler.

Remove and recondition regulating valves.

Remove, recondition and reapply lube oil  
priming pump, if used.

**SCHEDULE KEY & ITEM****RECOMMENDATION**

- |                            |                                                                                                                                                                         |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| (3A) Fuel Oil System       | Remove and recondition regulating valves.<br>Renew hoses and flexible couplings.<br>Remove and recondition fuel booster pump.<br>Replace fuel pump drive belt, if used. |
| (3A) Cooling System        | Renew hoses and flexible couplings.<br>Remove, recondition and reapply temperature regulating valves.                                                                   |
| (3A) Compressed Air System | Service air compressor in accordance with manufacturer's suggestions.                                                                                                   |

NOTE: All items in hourly (Group H), daily (Group D), weekly (Group W), monthly (Group M), quarterly (Group 3M), semi-annually (Group 6M) and annually (Group 1A) schedules apply.

# SALEM GENERATING STATION

PUBLIC SERVICE ELECTRIC & GAS COMPANY

MAINTENANCE DEPARTMENT MANUAL  
PROCEDURE APPROVAL COVER SHEET

PROCEDURE NO.: M15A TITLE: DIESEL GENERATOR INSPECTION

REMARKS:

(S.T.S. 4. 8. 1. 1. 2(b))

This is a safety related procedure. Documentation shall be retained for five years.

This procedure has been reviewed and determined to be in compliance with Technical Specification Requirements (Rev. 2.).

REVISION	SUBMITTED	EED APPROVED	QA REVIEWED	MAINT. ENGR. APPROVED	S.O.R.C. MTG. NO.	SUPERINTENDENT APPROVED
0	<i>A. K. Kuman</i> 7/29/76	NA	<i>A. Stillman</i> 7/30/76	<i>N. A. Selven</i> 7/30/76	62-76	<i>J. J. Keller</i> 7/30/76
1	<i>T. W. Yonchi</i> 10-29-76	NA	<i>A. Stillman</i> 11/1/76	<i>N. A. Selven</i> 11/3/76	100-76	<i>H. J. Keller</i> 11/5/76
2	<i>A. Stillman</i> 3-17-77	NA	<i>A. Stillman</i> 7/21/77	<i>N. A. Selven</i> 7/24/77	33-77	<i>J. J. Keller</i> 3/77
3	<i>D. Welch</i> 9-12-77	NA	<i>A. Stillman</i> 9/11/77	<i>N. A. Selven</i> 9/12/77	92-77	<i>J. J. Keller</i> 9/77

SALEM GENERATING STATION  
MAINTENANCE DEPARTMENT PROCEDURE M15A  
DIESEL GENERATOR INSPECTION  
(S.T.S. 4.8.1.1.2(b))

1.0 PURPOSE

The purpose of this procedure is to provide inspections to be conducted on the Emergency Diesel Engines and Generators in accordance with Reference 2.1.

2.0 REFERENCES

2.1 S.T.S. 4.8.1.1.2(b), Diesel Generator Inspection

2.2 Alco Manual DE-35245 Book I and II

3.0 RESPONSIBILITIES

3.1 The Maintenance Department is responsible for scheduling, conducting and recording inspection results.

4.0 PRECAUTIONS

4.1 The following items are not to be used when working on components of the primary system:

1. Carbon steel wire brushes
2. Tri chlorothene
3. Unapproved masking tape (other than use on protective clothing)

5.0 PREREQUISITES

5.1 Observe normal tagging procedures (AP-15).

5.2 Only one engine shall be tagged out at any time.

6.0 PROCEDURE

6.1 Conduct engine and generator inspection and record results in accordance with Figure 2.

6.2 Submit the completed inspection report to the Foreman/Supervisor.

7.0 RECORDS

7.1 Records shall consist of:

7.1.1 All cylinder compression pressures, firing pressures and temperature reports (Figure 1).

7.1.2 All inspection reports (Figure 2).

7.1.3 Injector pop pressures.

7.1.4 Corrective Action taken on inspection deficiencies noted.

SALEM GENERATING STATION  
 MAINTENANCE DEPARTMENT PROCEDURE M15A  
 DIESEL ENGINE INDICATOR READINGS  
 (S.T.S. 4. 8. 1. 1. 2(b))

Cylinder Firing Pressure Indicator and Temperature Readings. Allow temperatures to stabilize for 10 minutes before taking readings.

ENGINE NO. \_\_\_\_\_ Date \_\_\_\_\_

CYLINDER COMPRESSION PRESSURE	CYLINDER FIRING PRESSURE	CYLINDER TEMP.	CYLINDER COMPRESSION PRESSURE	CYLINDER FIRING PRESSURE	CYLINDER TEMP.
<u>RIGHT</u>			<u>LEFT</u>		
1.			1.		
2.			2.		
3.			3.		
4.			4.		
5.			5.		
6.			6.		
7.			7.		
8.			8.		
9.			9.		

Load Data Taken at \_\_\_\_\_ KW

Data Collected By: \_\_\_\_\_

Reviewed: \_\_\_\_\_  
 Foreman/Supervisor Date

NOTE: Governor side of engine is right, No. 1 cylinders are opposite end from generator.

Comments:

SALEM GENERATING STATION  
MAINTENANCE DEPARTMENT PROCEDURE M15A  
DIESEL ENGINE INSPECTION  
(S.T.S. 4.8.1.1.2(b))

ENGINE NO. \_\_\_\_\_ DATE \_\_\_\_\_

1.0 ENGINE INSPECTION

INITIAL

1.1 Review the last Diesel Engine Inspection for indications of problem areas to be investigated. \_\_\_\_\_

1.2 Remove all valve and crankcase inspection covers. Inspect externals and internals for leaks, loose nuts and bolts, linkage, tubing connections and foreign materials. \_\_\_\_\_

1.3 Check and record crankshaft deflection (record reading on reverse side of sheet). \_\_\_\_\_

1.4 Check valve clearance and injector timing. Instructions on Figure 3. (Record adjustment made to clearances and timing on reverse side of sheet.) \_\_\_\_\_

1.5 Remove and test injector nozzles pop pressures. Injector nozzles are acceptable if pressure is between 3500 psig to 4100 psig. Consult Tech. Manual for method of testing. (Record pop pressures on reverse side of sheet.) \_\_\_\_\_

1.6 Replace all engine covers. \_\_\_\_\_

1.7 Conduct test start and load unit to 1400 KW. \_\_\_\_\_

1.8 Record cylinder compression pressure, firing pressure and firing temperatures. Maintain the 1400 KW load. (Record on Figure 1.) \_\_\_\_\_

2.0 GENERATOR INSPECTION

INITIAL

2.1 Cleanliness.

\_\_\_\_\_

2.2 Check for loose parts and connections.

\_\_\_\_\_

2.3 Check protective covers and screens in place and not damaged.

\_\_\_\_\_

2.4 Check generator exciter.

2.4.1 Brush tension.

\_\_\_\_\_

2.4.2 Brush condition.

\_\_\_\_\_

2.4.3 Slip ring surface.

\_\_\_\_\_

3.0 POST INSPECTION TEST:

3.1 Request Operations:

3.1.1 Test engine overspeed device trip speed setting.

\_\_\_\_\_

Inspection Conducted By: \_\_\_\_\_

Reviewed By: \_\_\_\_\_ Date \_\_\_\_\_  
Foreman/Supervisor



## VALVE ADJUSTMENT INSTRUCTIONS

Rotate engine in correct rotation until No. 1R (as stamped on flywheel) aligns with "INJ" pointer and both push rods and rocker arms are horizontally even. If one push rod is higher, turn engine one revolution and again align 1R with "INJ". After 1R is aligned, follow firing order and insure that when each cyl. no. on flywheel is aligned with "INJ" that push rods are horizontally even. Adjust push rods to specs. per instruction manual if required. (.034" to .037" is required clearance.)

Questionnaire

for

NUCLEAR REGULATORY COMMISSION  
RELIABILITY STUDY

of

Standby Diesel Generator Units

Date Questionnaire Completed: January 18, 1978

Plant Name: Salem Unit No. 1

Diesel Manufacturer: Alco Engine Inc. Model: 9 X 10 - 1/2  
Model 18-251

Number of Units: 3

Size Kw/Unit: 2600 cont. Rated Speed: 900 rpm

Average Operating Hours Per Unit to Date: 30 hrs

DIESEL GENERATOR STATUS

A. Engine:

1. Problems are caused chiefly by (give estimated number)

- a. Defective parts X
- b. Installation errors: \_\_\_\_\_
- c. Failure of system to respond properly in function or sequence: \_\_\_\_\_
- d. Faulty adjustment: \_\_\_\_\_

2. Would more stringent inspection and testing requirements during acceptance or preoperational tests significantly improve the diesel-generator power plant performance?  
Yes \_\_\_\_\_ No X

B. Starting Systems (indicate which):

- 1. Air-to-cylinder cranking. X Ingersol  
Air cranking motor 4 Mfr. Rand Model No. B41RH1  
Electric cranking motor \_\_\_\_\_ Mfr. \_\_\_\_\_ Model No. \_\_\_\_\_

2. If air cranking, then:

Give size of starting air tank: Length 8' 0" Diameter 3" 0"

Normal standby air tank pressure 230 psi.

Is pressure reducer used? Yes X No     

Reducer pipe size? 1½-2-1½ inches.

Starting air control admission valve pipe size in air piping system, 1½ inches.

Minimum air tank pressure for engine cranking 50 psi.

Number of <sup>starts</sup> ~~five-second~~ cranking periods between above pressures with no tank recharging 22.

Number of air tanks per engine 2.

Can starting air tanks serve more than one engine?

Yes      No X

Is air pipe to engine from top of air tank? Yes X No     

Does starting air tank have water condensate drain?

Yes X No     

Does starting air pipe have water condensate trap and drain near engine? Yes      No X

Is starting air piping horizontal? Yes X No     

Does it slant toward drain? Yes      No X

If water condensate drains are provided, then is draining:

a. Automatic through float valve? Yes      No X

b. Manual by hand valve? Yes X No     

c. If manual, then is draining water condensate done:

daily? X  
weekly?       
monthly?       
before each start if manual?       
no procedure?     

Is dirt and rust filter provided in starting air pipe?  
Yes      No X

If provided, where installed? \_\_\_\_\_  
\_\_\_\_\_

How is it cleaned? \_\_\_\_\_

How often and when? \_\_\_\_\_

Give pipe size of filter: \_\_\_\_\_ inches.

How is it known whether filter is plugged or has high pressure drop? \_\_\_\_\_  
\_\_\_\_\_

Is starting air pipe to engine positioned:

- a. Below floor?
- b. On the floor?
- c. Overhead? X

What is air pressure drop from air tank to engine during cranking 60-67 psi

Give approximate length (nearest ten feet) of starting air pipe for individual engine or all engines from air tank to:

- a. Nearest <sup>starting</sup> ~~engine~~ <sup>motor</sup> 20 feet
- b. Furthest ~~engine~~ 40 feet

Diameter of starting air pipe from:

- a. Air tank to starting valve  $1\frac{1}{2}$ -2 inches
- b. At air starting valve  $1\frac{1}{2}$  inches
- c. At engine  $1\frac{1}{2}$  inches

What is the primary source of power for the starting air system? vital bus

Is there a duplicate and redundant motor and air compressor set? Yes  No

What is the time required to recharge one air tank?  
UN minutes

Does starting air supply system have independent secondary power supply for compressor? Yes  No

If yes, then by:

- a. Gasoline engine?
- b. Motor driven?
- c. Other? (Specify)

3. If electric (Battery powered) cranking, then: N/A

- a. Battery charging: Continuous trickle charger   
Intermittent charging

If so, how is charging requirement determined?

Time cycle

Test

Other

- b. Battery used: Common Plant   
Individual Unit   
Other

Starting cable size  ; Length: Battery to engine (longest)

C. Fuel Oil System: Bulk Tank to Day Tank

1. Does the bulk tank to day tank fuel supply system (viz: pump, motor, etc.) have redundant independent power supplies? Yes X No

Does this system have a hand-operated emergency fuel pump? Yes      No X

If yes, is this hand-operated pump and piping in immediate operating condition? Yes      No     

2. Is there a water and sediment drain from the very bottom of the:
- a. Bulk tank? Yes      No X
- b. Day tank? Yes      No X

3. Is the regular functional fuel oil outlet slightly above (two to three inches) the bottom of the:
- a. Bulk tank? Yes      No X
- b. Day or integral tank? Yes      No X

4. Is bottom of day tank and/or integral tank above all parts and piping of the engine fuel injection systems? Yes X No

If yes,

Give approximate amount inches 0 feet 15

5. Does the engine fuel system have a fuel bleed return line to the fuel day tank and/or integral tank? Yes X No

During extended operation, such as more than two to three hours, does the fuel in the day tank become: (~~yes-or~~ no)

- a. Warm?
- b. Hot?      (above 130°F)

What is fuel oil return line size (nominal)?

- a. Pipe size 3/4 inches
  - b. Tubing size \_\_\_\_\_ inches
6. Do engine fuel oil filters have air bleed or vent valves readily accessible? Yes \_\_\_\_\_ No X
7. How is fuel transferred from day tank to engine fuel system?
- a. By gravity X 30.4gpm
  - b. Engine driven pump \_\_\_\_\_
  - c. Electric motor driven pump \_\_\_\_\_
  - d. Is a manual pump also provided for injection system filling and/or air venting after servicing or replacement of parts in the fuel injection system? Yes \_\_\_\_\_ No X

If yes, is the manual pump in immediate operating condition?  
Yes \_\_\_\_\_ No \_\_\_\_\_

8. Type of fuel (e.g., #1, #2, #3, JP-4, etc.) #2.
9. Approximate bulk tank capacity, 60,000 gallons.- 2 tanks  
30,000 gal. ea.
10. Typical frequency of refilling (weekly, monthly, etc.) unknown.  
automatic transfer system
11. Typical refill (gallons), \_\_\_\_\_.

D. Lube Oil System

1. Lube oil
- a. Type Exxon Diol RDX
  - b. Viscosity \_\_\_\_\_ High Dispersance - Mil-L-2104B
  - c. Specification number \_\_\_\_\_
  - d. Oil change determined by:  
  
Time interval: Yes \_\_\_\_\_ No X  
Give interval \_\_\_\_\_ monthly, yearly  
By oil analysis: Yes X No \_\_\_\_\_

2. Lube oil filters are:

- a. Full flow   X
- b. Bypass
- c. Combination

3. Interval and/or basis for changing filter cartridge:

- a. Monthly
- b. Yearly   X
- c. By running time            hours
- d. By oil analysis. Yes        No
- e. By pressure drop. Yes        No
- f. Does provisions exist for changing cartridges during engine operation? Yes        No   X

4. Oil Pressure Monitoring

- a. Normal operating pressure   80   psi
- b. Alarm   60   psi
- c. Shutdown   40   psi

5. Oil temperature control:

- a. By standby heater in engine sump   110   °F.
- b. Heating means for maintaining standby temperature:

Direct in oil   X    
Oil-to-water heat exchanger             
Other (Specify)           

E. Cooling System - Engine Water

1. Temperature control by:

- a. By thermostat in water? Yes        No   X

If yes, then:

Bypass thermostat? Yes        No         
Throttle thermostat? Yes   X   No



b. By radiator shutter:

Automatic \_\_\_\_\_

Manual \_\_\_\_\_

Other (give type) thermostat controls cooling water flow

2. Corrosion control (water additive)? Yes X No \_\_\_\_\_

If yes, give chemical additive or name of compound.

K<sub>2</sub>CrO<sub>4</sub>

Proportion or concentration control:

a. By additive measurement? Yes \_\_\_\_\_ No \_\_\_\_\_

b. By water coolant analysis? Yes X No \_\_\_\_\_

3. Engine cooling water cooled by:

a. Radiator? \_\_\_\_\_

b. Heat exchanger from sea, river or other water? X

c. Other? (give type) \_\_\_\_\_

4. Engine cooling water temperature-monitoring

a. Standby temperature 120 °F

b. Normal operating temperature 170 °F

c. Alarm temperature 175 °F

d. Shutdown temperature 195 °F

e. Water circulation during standby:

Thermo-syphon \_\_\_\_\_

Pump \_\_\_\_\_

Natural convection \_\_\_\_\_

5. Water Pressure Monitoring: Yes X No \_\_\_\_\_

a. Alarm 175

b. Shutdown 195

c. Both \_\_\_\_\_

6. Water temperature Sensor Position:

- a. In piping from engine
- b. In engine piping \_\_\_\_\_
- c. In engine direct \_\_\_\_\_

7. Water surge or supply tank in system. Yes  No \_\_\_\_\_

If yes, then bottom connected to:

- a. Water pump suction? Yes  No \_\_\_\_\_
- b. Top of system? Yes \_\_\_\_\_ No \_\_\_\_\_
- c. Both of above? Yes \_\_\_\_\_ No \_\_\_\_\_
- d. Is bottom of surge tank above top of engine system? Yes  No \_\_\_\_\_
- e. Does engine have constant air bleed from top of engine water piping to surge or supply tank? Yes  No \_\_\_\_\_
- f. Give size of bleed or vent line,  $\frac{3}{4}$  inches.
- g. Manual air bleed only? Yes  No \_\_\_\_\_

F. Governor - Speed Control

Manufacturer Woodward

Electric (speed sensing) \_\_\_\_\_

Hydraulic

Type or code (such as EGB-35, LSG-10, etc.) EG-B10

Automatic load sharing? Yes \_\_\_\_\_ No

1. Is compensation or stability control and/or speed of response manually adjustable? Yes  No \_\_\_\_\_

If yes, adjusted by:

- a. Eye and ear?
- b. Test and specification?
- c. Other? (Specify) \_\_\_\_\_.

2. Engine - generator normal shutdown or stopping means and method.

Is the engine stopped:

a. Manually? Yes X No     

If yes, then:

Directly at engine? Yes      No       
Through local control panel? Yes X No     

b. Automatically through the controls in the control room? Yes      No X

c. By setting governor to "fuel-off" position? Yes      No X

d. By over-ride of governor settings and control position directly to fuel injection pumps? Yes      No X

e. Other means. Describe briefly.                                 

3. When engine is stopped, is fuel control in:

- a. Full fuel or maximum fuel position?
- b. Full off or no fuel position? X
- c. Intermediate?
- d. Random?

(If not consistent and typical in above, then give the usual.)

4. When starting from the standby condition after shutdown for at least 24 hours, give number of seconds from start-to-crank to full fuel or maximum fuel position of governor and fuel control,     1     seconds.

G. Governor - Overspeed (shutdown)

1. Speed sensing?

- a. Electrical \_\_\_\_\_
- b. Flyball  \_\_\_\_\_
- c. Other (Specify) \_\_\_\_\_

2. Fuel shutoff force generated by:

- a. Spring? \_\_\_\_\_
- b. Air? \_\_\_\_\_
- c. Hydraulic? \_\_\_\_\_
- d. Electrical?  \_\_\_\_\_
- e. Other? (Specify) \_\_\_\_\_

3. Overspeed sensing setting? (in terms of full speed)

- a. 115% \_\_\_\_\_
- b. 110% \_\_\_\_\_
- c. Other (Specify) 117%

4. Is overspeed tripping set point tested periodically?

Yes  No \_\_\_\_\_

If yes, then how often? 18 mos. (yearly, monthly, etc.)

H. 1. Generator Mfr. Elec. Mach. Co. Model No. 8G6237  
Single bearing or two bearings? single  
Does generator have damper windings? Yes \_\_\_\_\_ No

2. Does generator have any obvious fault or difficulty?  
Yes \_\_\_\_\_ No

Is problem repetitive? Yes \_\_\_\_\_ No \_\_\_\_\_

If yes, then describe briefly. \_\_\_\_\_

I. Exciter and Voltage Regulator

1. Exciter Manufacturer: Basler Model \_\_\_\_\_

Type: Rotating \_\_\_\_\_ Static X

If rotating drive? Direct \_\_\_\_\_  
Belt or Chain \_\_\_\_\_  
DC with field control \_\_\_\_\_  
Brushless with rectifier \_\_\_\_\_

2. Voltage Regulator: Manufacturer Basler Model \_\_\_\_\_

Type: Mechanical \_\_\_\_\_ Static X

3. Are paralleled units of automatic load sharing control of fully automatic type? Yes \_\_\_\_\_ No X

If yes, has any obvious influence or interrelationship been noted between the stability and response time of the engine governor and the stability and voltage control of the generators? Yes \_\_\_\_\_ No \_\_\_\_\_

4. Have engine governor and voltage regulator/exciter adjustments been made on the site or under any conditions since any of the units have been placed in service? Yes \_\_\_\_\_ No X

If yes, by means of what tests and what standards? Give name or very brief description. \_\_\_\_\_

\_\_\_\_\_

5. If any difficulties have occurred, give approximate number of problems.

- a. Components X
- b. Wiring \_\_\_\_\_
- c. Other (damage in service or dropping of miscellaneous hardware into switchboard, etc.) \_\_\_\_\_  
voltraps failures \_\_\_\_\_

J. Paralleling: Engine-Generator Units

1. Do all units consistently have the proper voltage output?  
Yes X No
2. Do all units automatically share both the "real" or in-phase load and also the reactive load reasonably well? Yes X No      parallel during load test only
3. At the same Kw load, are both the field and the armature line currents of the several units consistently close to the same value? Yes X No

If no, approximate percent difference.                     

4. Synchronizing

- a. In automatic synchronizing do circuit breakers close immediately after reaching full synchronous speed?  
(and voltage) Yes      No X
- b. If "no" above then, does speed of some units drift slowly while failing to synchronize and close circuit breakers?

How many seconds?     -    

Occasionally     -    

Always     -    

Never     -    

K. Switch Gear and Electrical Con. (other than exciter/voltage regulator)

1. If any difficulties have occurred, then give approximate number of problems.
  - a. Components
  - b. Wiring
  - c. Other (damage in service or dropping of miscellaneous hardware into switchboard, etc.)
  - d. Design concept faults. That is, does the switch gear and its controls perform the proper functions and in proper sequence and timing.

2. a. Do the on-site diesel generator units and related support equipment have any storage battery power systems for any service whatsoever? Yes X No
- b. Identify each storage battery power system associated with the on-site diesel generator unit and its function. 125v and 28v control and field flashing  
\_\_\_\_\_  
\_\_\_\_\_
- c. Does each system identified above adequately fulfill the service requirements for which it is intended? Yes X No       
  
If no, briefly describe. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
- d. Is there a ~~DC~~ battery maintenance program? Yes X No

L. Safety Shut downs

Give safety shut down settings compared to equilibrium operating conditions.

1. Engine and generator speed. Give rpm or hertz:
- a. Synchronous and usual 900 rpm or 60 Hz  
b. Overspeed shutdown setting 1060 rpm or      Hz
2. Engine cooling water (see E.4)
- a. Equilibrium 170 °F  
b. Alarm 175 °F  
c. Shut down 195 °F
3. Lube oil pressure (see D.4)
- a. Equilibrium 80 psi  
b. Alarm 60 psi  
c. Shut down 40 psi

4. Lube oil temperature

- a. Equilibrium 180 °F
- b. Alarm 185 °F
- c. Shutdown 195 °F

5. Indicate all other protective interlocks (give name and;)

a. Usual or proper condition crank less than 10 sec.

b. Shutdown condition overcrank greater than 10 sec.

6. a. What source of power is provided to operate alarms and shutdown controls? (See G.2) 125vdc

b. Do the generator units automatically shutdown in case of the electrical power loss to its control system? Yes  No

M. Emergency or Alert Conditions

1. Are all safety shutdown and safety interlocks bypassed during emergency conditions? Yes  No

2. If "no" above, then which are not bypassed. Name items.

ground fault, diff. current, loss of excitation

overspeed, local or remote stop pushbutton, emer. stop lube oil press less than 40 psi

3. For each interlock not bypassed is coincident logic used? Yes  No

If yes, is it testable? Yes  No

N. Maintenance

1. Does plant have regularly scheduled maintenance procedures? yes

If so, return copy of these procedures with questionnaire.

use Alco Technical Manual for annual overhaul

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2. When need for minor adjustments obviously exists, then:

- a. Is remedial action taken immediately or at earliest practical opportunity? Yes  No
- b. Is remedial action taken only at periodic prescheduled or programmed times and conditions? Yes  No
- c. For best performance record which of above appears better:  
immediate or early action?   
as scheduled only?
- d. Must permission for minor maintenace be obtained from some higher out-of-plant authority? Yes  No
- e. Is maintenance referred to above allowed and encouraged? Yes  No
- f. In periodic surveillance tests, simulated alert standby tests, etc., is the criteria "pass/not pass" the test used? Yes  No
- g. Is there a conscious continuing policy to detect and remedy marginal conditions or imminent trouble: for examples: lube oil pressure shutdown only two to five psi below operating pressure or, perhaps overspeed governor setting only one or two percent above starting speed surge or etc.? Yes  No
- h. Are efforts to remedy marginal or questionable conditions as mentioned above encouraged by plant management?   
Yes  No
- i. Are remedial steps on items similar to the above taken or allowed when the unit has started and operated satisfactorily within specified limits or conditions? Yes  No

0. Starting Conditions

1. Give starting or necessary cranking time as experienced.

- a. Starting time per specification 10 seconds
- b. Usual starting time 8-9 seconds
- c. Maximum starting time observed 13 seconds during SUP

2. Give usual time intervals as follows:

- a. Time from start-to-crank to first firing of any cylinder. 2 seconds
- b. Time from start-to-crank to approximate full firing of all cylinders. 5 seconds

3. Give maximum speed surge when starting; use both tachometer and frequency meter if possible.

- a. Usual conditions 900 rpm  
60 Hz
- b. Maximum observed 930 rpm  
62 Hz

4. During a surveillance test, give time from start-to-crank to when steady synchronous speed is attained and maintained.

- a. Usual 7-8 seconds
- b. Maximum 9 seconds
- c. As specified 10 seconds.

5. Give briefly the most troublesome problems in starting.

- a. Most troublesome fuel rack resetting.
- b. Next to most troublesome no other significant problems

P. Air Cleaner or Air Filter - Combustion Air

1. Combustion air source: taken from engine room or inside the building, or from outdoors?

- a. Indoors \_\_\_\_\_
- b. Outdoors X

2. Give type and make of air cleaners or air filters:

- a. Oil bath \_\_\_\_\_ Make \_\_\_\_\_
- b. Oil wetted screen \_\_\_\_\_ Make \_\_\_\_\_
- c. Paper X \_\_\_\_\_ Make \_\_\_\_\_
- d. Other \_\_\_\_\_ Make \_\_\_\_\_
- e. Precleaner: Yes \_\_\_\_\_ No \_\_\_\_\_

3. Excessive air flow restriction and servicing need determined by?

- a. Instrument such as:  
manometer \_\_\_\_\_  
If other give type \_\_\_\_\_
- b. Personal judgement by appearance, etc. X
- c. By smoking exhaust \_\_\_\_\_
- d. Time schedule \_\_\_\_\_
- e. Other (Specify) \_\_\_\_\_

4. Are climatic extremes normally experienced such as:

- a. Air heavily loaded with water mist, high humidity and low temperature? Yes \_\_\_\_\_ No X
- b. Blowing sand and dust? Yes \_\_\_\_\_ No X
- c. Blowing snow (blizzards)? Yes \_\_\_\_\_ No X
- d. Other-Name \_\_\_\_\_

5. Are climatic extremes potentially possible such as:

- a. Air heavily loaded with water mist, high humidity and low temperature? Yes X No \_\_\_\_\_
- b. Blowing sand and dust? Yes \_\_\_\_\_ No X
- c. Blowing snow (blizzards)? Yes \_\_\_\_\_ No \_\_\_\_\_
- d. Other-Name \_\_\_\_\_

Q. Temperature Conditions

- 1. Ambient outside hottest 98 °F.
- 2. Ambient outside coldest 0 °F.
- 3. Engine-generator room hottest 110 °F.
- 4. Engine-generator room coldest 50 °F.
- 5. Inside switch gear hottest 75
- 6. Inside voltage regulator or ambient near voltage regulator hottest 95
- 7. Ambient at exciter hottest 95

R. Operator Qualifications (as presently exists, and suggested minimums if different)

1. Minimum education required (check)

	<u>Existing</u>	<u>Suggested</u>
a. High School	<u>X</u>	<u>          </u>
b. Trade School	<u>          </u>	<u>          </u>
c. Technical School	<u>          </u>	<u>          </u>
d. No minimum	<u>          </u>	<u>          </u>

2. Minimum Years of operating experience (diesel electric generator)

	<u>Existing</u>	<u>Suggested</u>
a. 0-3	<u>X</u>	<u>          </u>
b. 3-6	<u>          </u>	<u>X</u>
c. 6-10	<u>          </u>	<u>          </u>
d. 10-15	<u>          </u>	<u>          </u>

3. Operator training

	<u>Existing</u>	<u>Suggested</u>
a. Military	<u>          </u>	<u>          </u>
b. Industrial	<u>          </u>	<u>          </u>
c. On-the-job	<u>          </u>	<u>          </u>
d. Combination of a, b, and c (indicate which)	<u>X</u>	<u>          </u>

4. Licensing required

	<u>Existing</u>	<u>Suggested</u>
a. State	<u>X</u>	<u>          </u>
b. Federal	<u>          </u>	<u>          </u>
c. Utility or self	<u>          </u>	<u>          </u>
d. None	<u>          </u>	<u>          </u>

S. Are any foreign gases such as propane, freon, halon, carbon dioxide, etc. stored in the: Diesel Engine room?

Yes \_\_\_\_\_ No X or adjacent buildings? Yes \_\_\_\_\_ No X

If yes, (other than hand portable fire extinguishers), then identify gases and give approximate tank size.

Gases _____	Volume (ft <sup>3</sup> ) _____
_____	_____
_____	_____
_____	_____

T. Does control system automatically bypass, in emergency starting, any engine temporarily out of service for maintenance? Yes \_\_\_\_\_ No X

If yes, then how many failures to bypass have occurred?

\_\_\_\_\_

U. Does the control system automatically override the test mode under emergency conditions? Yes X No \_\_\_\_\_

V. Have repetitive mechanical failures occurred in any component part or subsystem of the engine, generator, or switch gear, etc.?

Yes X No \_\_\_\_\_

If yes, then which part or subsystem? fuel line to manifold

How many failures? 2

Give nature of failure. vibration cracking

\_\_\_\_\_  
\_\_\_\_\_

W. Would periodic (yearly or other) evaluation and/or testing by "outside experts" contribute significantly to the diesel-generator reliability? Yes X No \_\_\_\_\_

Give brief reasons for the answer. Experts are highly trained and experienced in specific equipment

\_\_\_\_\_  
\_\_\_\_\_

- X. 1. Give the accumulated time-load operating record for each diesel-generator unit from installation to the present (Running Hours):

Preoperational test Date Dec. 1975

Engine Serial No.	Surv. Testing & Maintenance Hrs. No Load	Emergency and Other Loaded Service Hrs.	Total Hours
	Unavailable at this time		

2. Surveillance test load (percent of continuous rating) 100%

3. Give the projected or planned time-load operation for each diesel-generator unit during the next 12 months.

Surveillance & Maintenance Hrs.	Emergency and other Service Hrs.	Total Hours
130		30

4. Provide the following summary of the periodic surveillance testing experience:

- a. Starting date of surveillance testing (OL date) Jan 1976  
 b. Periodic test interval 31 days / & 18 mos.  
 c. Total number of surveillance tests performed 24 per unit  
 d. Total number of test failures 5

failure to start \_\_\_\_\_ failure to accept load \_\_\_\_\_  
 failure to carry load \_\_\_\_\_ failures due to operator error \_\_\_\_\_  
 failure due to equipment not being operative during emergency  
 conditions 5

- e. Supply a copy of the surveillance test procedures with this completed questionnaire.

Additional Comments

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Y. General Suggestions

Briefly give constructive criticism or suggestions as to improvement in reliability of the diesel generators. These remarks may cover tests, maintenance, practices, orders, policy, adjustments, etc.