

50-289

RESPONSE TO QUESTIONNAIRE FOR NRC RELIABILITY
STUDY OF STANDBY DIESEL GENERATOR UNITS

W/ltf 1-30-78 740270311

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Questionnaire
for
NUCLEAR REGULATORY COMMISSION
RELIABILITY STUDY
of
Standby Diesel Generator Units

Date Questionnaire Completed: 1-5-78
Plant Name: Three Mile Island Unit No. 1
Diesel Manufacturer: Fairbanks-Morse Model: 3800 TD B 1/8
Number of Units: 2
Size Kw/Unit: 3000 KW Rated Speed: 900 RPM
Average Operating Hours Per Unit to Date: 426

DIESEL GENERATOR STATUS

A. Engine:

1. Problems are caused chiefly by (give estimated number)
 - a. Defective parts 2
 - b. Installation errors: 0
 - c. Failure of system to respond properly in function or sequence: 0
 - d. Faulty adjustment: 0
 - e. Operator Error-Exact Number not known but this ^{is} most frequent failure.
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. Yes

Air cranking motor	<u>No</u>	Mfr.	<u>N/A</u>	Model No.	<u>N/A</u>
Electric cranking motor	<u>No</u>	Mfr.	<u>N/A</u>	Model No.	<u>N/A</u>

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2. If air cranking, then:

Give size of starting air tank: Length 103" Diameter 30"

Normal standby air tank pressure 250 psi.

Is pressure reducer used? Yes No X

Reducer pipe size? N/A inches.

Starting air control admission valve pipe size in air piping system, 1 1/2 inches.

Minimum air tank pressure for engine cranking 75 psi.

Number of five-second cranking periods between above pressures with no tank recharging UN.

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 (Off bottom of start air receiver)

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

Is starting air piping horizontal? Yes No Both X

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:

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

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

If provided, where installed? Upstream of air start solenoid
valves. _____

How is it cleaned? "Y" Strainers - Manual _____

How often and when? Annually - Year end _____

Give pipe size of filter: 2 1/2 inches.

How is it known whether filter is plugged or has high pressure drop? No DPI installed - Not known _____

Is starting air pipe to engine positioned:

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

What is air pressure drop from air tank to engine during cranking N/A psi

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

- a. Nearest engine 25 feet
- b. Furthest engine 25 feet

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Diameter of starting air pipe from:

- a. Air tank to starting valve 2 1/2 inches
- b. At air starting valve 1 1/2 inches
- c. At engine 1 1/2 inches

What is the primary source of power for the starting air system? Elec Air Compressor

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

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 X No

If yes, then by:

- a. Gasoline engine? No
- b. Motor driven? No
- c. Other? (Specify) ONAN Diesel Engine

This Section
is N/A.

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

- 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 N/A No N/A

2. Is there a water and sediment drain from the very bottom of the:

a. Bulk tank? Yes No X
b. Day tank? Yes X No

3. Is the regular functional fuel oil outlet slightly above (two to three inches) the bottom of the:

a. Bulk tank? Yes X No
b. Day or integral tank? Yes X No

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

If yes,

Give approximate amount inches N/A feet N/A

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? No
b. Hot? No (above 130°F)

What is fuel oil return line size (nominal)?

- a. Pipe size 3/4 inches
- b. Tubing size UN inches

6. Do engine fuel oil filters have air bleed or vent valves plugs readily accessible? Yes x No

7. How is fuel transferred from day tank to engine fuel system?

- a. By gravity No
- b. Engine driven pump x (At rated speed)
- c. Electric motor driven pump x (Below rated speed)
- 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 N/A No N/A

8. Type of fuel (e.g., #1, #2, #3, JP-4, etc.) #2.

9. Approximate bulk tank capacity, 30,000 gallons.

10. Typical frequency of refilling (weekly, monthly, etc.) every 2 mos nominally.

11. Typical refill (gallons), 2,000 nominally.

D. Lube Oil System

1. Lube oil

- a. Type Ester GLX-30
- b. Viscosity SAE 30
- c. Specification number UN
- d. Oil change determined by:

Time interval: Yes No x
Give interval N/A monthly, yearly
By oil analysis: Yes x No

2. Lube oil filters are:

- a. Full flow No
- b. Bypass No
- c. Combination Yes

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

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

4. Oil Pressure Monitoring

- a. Normal operating pressure 31 psi
- b. Alarm 16 psi
- c. Shutdown 16 psi

5. Oil temperature control:

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

Direct in oil No
Oil-to-water heat exchanger Yes
Other (Specify) No

E. Cooling System - Engine Water

1. Temperature control by:

- a. By thermostat in water? Yes X No

If yes, then:

Bypass thermostat? Yes X No
Throttle thermostat? Yes No X

b. By radiator shutter: None

Automatic No

Manual No

Other (give type) No

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

If yes, give chemical additive or name of compound.

Permanent Antifreeze - Brand Name

Proportion or concentration control:

a. By additive measurement? Yes No X

b. By water coolant analysis? Yes X No

3. Engine cooling water cooled by:

a. Radiator? X

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

c. Other? (give type) X

4. Engine cooling water temperature-monitoring

a. Standby temperature 120 °F

b. Normal operating temperature 120-180 °F

c. Alarm temperature 195 °F

d. Shutdown temperature None °F

e. Water circulation during standby:

Thermo-syphon No

Pump Yes

5. Water Pressure Monitoring: Yes X No

a. Alarm Yes

b. Shutdown No

c. Both No

6. Water temperature Sensor Position:

- a. In piping from engine Yes
- b. In engine piping No
- c. In engine direct No

7. Water surge or supply tank in system. Yes X No

If yes, then bottom connected to:

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

F. Governor - Speed Control

Manufacturer Woodward
Electric (speed sensing) No
Hydraulic Yes
Type or code (such as EGB-35, LSC-10, etc.) VGB
Automatic load sharing? Yes X No

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

If yes, adjusted by:

- a. Eye and ear? No
- b. Test and specification? Yes
- c. Other? (Specify) No

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

Electrically Trip out Fuel Racks and Manually

Is the engine stopped:

a. Manually? Yes X No

If yes, then:

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

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

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 Un No Un

e. Other means. Describe briefly. No

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

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

(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.

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G. Governor - Overspeed (shutdown)

1. Speed sensing?

- a. Electrical Yes
- b. Flyball Yes
- c. Other (Specify) No

2. Fuel shutoff force generated by:

- a. Spring? Yes
- b. Air? No
- c. Hydraulic? No
- d. Electrical? No
- e. Other? (Specify) No

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

- a. 115% No
- b. 110% No
- c. Other (Specify) A Diesel @ 114.45%; B Diesel @ 115.55%

4. Is overspeed tripping set point tested periodically?

Yes No X

If yes, then how often? N/A (yearly, monthly, etc.)

- H. 1. Generator Mfr. Fairbanks Morse Type No. TGZDJ
Single bearing or two bearings? 2
Does generator have damper windings? Yes No X

2. Does generator have any obvious fault or difficulty?

Yes No X

Is problem repetitive? Yes No X

If yes, then describe briefly. N/A

I. Exciter and Voltage Regulator

1. Exciter Manufacturer: Basler Model SBHV

Type: Rotating No Static Yes

If rotating drive? Direct N/A
Belt or Chain N/A
DC with field control N/A
Brushless with rectifier N/A

2. Voltage Regulator: Manufacturer Basler Model SBHV

Type: Mechanical No Static Yes

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 X

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 X No

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

Maintenance Procedure #1420-EG-1

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

a. Components 0

b. Wiring 0

c. Other (damage in service or dropping of miscellaneous hardware into switchboard, etc.) 0

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J. Paralleling: Engine-Generator Units - This Section N/A

1. Do all units consistently have the proper voltage output?
Yes No
2. Do all units automatically share both the "real" or in-phase load and also the reactive load reasonably well? Yes No
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 No

If no, approximate percent difference. _____

4. Synchronizing

- a. In automatic synchronizing do circuit breakers close immediately after reaching full synchronous speed?
Yes No
- 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 1
 - b. Wiring 0
 - c. Other (damage in service or dropping of miscellaneous hardware into switchboard, etc.) 0
 - d. Design concept faults. That is, does the switch gear and its controls perform the proper functions and in proper sequence and timing. 0

2. a. Do the on-site diesel generator units and related support equipment have any storage battery power systems for any service whatsoever? Yes No
- b. Identify each storage battery power system associated with the on-site diesel generator unit and its function. Start Emerg. Air Compressor Diesel

- c. Does each system identified above adequately fulfill the service requirements for which it is intended? Yes No
If no, briefly describe. _____

- d. Is there a DG battery maintenance program? Yes 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 _____ Hz
b. Overspeed shutdown setting 1030 for "A" rpm or _____ Hz
1040 for "B"
2. Engine cooling water (see E.4)
- a. Equilibrium 175 °F
b. Alarm 195 °F
c. Shut down None °F
3. Lube oil pressure (see D.4)
- a. Equilibrium 31 psi
b. Alarm 16 psi
c. Shut down 16 psi

4. Lube oil temperature

- a. Equilibrium 180 °F
- b. Alarm 90 °F
- c. Shutdown None °F

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

- a. Usual or proper condition Crankcase Hi Press S/D

- b. Shutdown condition Cranking Timer - Max 7 Secs Manual & Auto
Start (1 timer each) Low Starting Lube Oil Press.

6. a. What source of power is provided to operate alarms and shutdown controls? (See G.2) 125 VDC
- 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.
Low Lube Oil Press, Crankcase Press Hi, Eng Overspeed

3. For each interlock not bypassed is coincident logic used? Yes No
- If yes, is it testable? Yes N/A No N/A

N. Maintenance

1. Does plant have regularly scheduled maintenance procedures? Yes
- If so, return copy of these procedures with questionnaire.
See 1001-0.2 Attached

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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 X No
- b. Is remedial action taken only at periodic prescheduled or programmed times and conditions? Yes No X
- c. For best performance record which of above appears better:
 immediate or early action? Yes
 as scheduled only? No
- d. Must permission for minor maintenance be obtained from some higher out-of-plant authority? Yes No X
- e. Is maintenance referred to above allowed and encouraged? Yes X No
- f. In periodic surveillance tests, simulated alert standby tests, etc., is the criteria "pass/not pass" the test used? Yes X No
- g. Is there a conscious continuing policy to detect and remedy marginal condition 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 X No
- h. Are efforts to remedy marginal or questionable conditions as mentioned above encouraged by plant management?
 Yes X 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 X No

0. Starting Conditions

1. Give starting or necessary cranking time as experienced.

- a. Starting time per specification 7 seconds
- b. Usual starting time 4-5 seconds
- c. Maximum starting time observed <7 seconds

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2. Give usual time intervals as follows:

- a. Time from start-to-crank to first firing of any cylinder. UN seconds
- b. Time from start-to-crank to approximate full firing of all cylinders. 4-5 seconds

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

- a. Usual conditions UN rpm
UN Hz
- b. Maximum observed UN rpm
UN Hz

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

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

5. Give briefly the most troublesome problems in starting.

- a. Most troublesome Lube Oil Press Switches.
- b. Next to most troublesome None.

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 Yes
- b. Outdoors No

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

- a. Oil bath No Make N/A
- b. Oil wetted screen Yes Make Not Known
- c. Paper No Make N/A
- d. Other No Make N/A
- e. Precleaner: Yes No X

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

a. Instrument such as:

manometer X

If other give type N/A

b. Personal judgement by appearance, etc. Air Filter Inspection

c. By smoking exhaust No

d. Time schedule Annual

e. Other (Specify) No

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 No X

b. Blowing sand and dust? Yes No X

c. Blowing snow (blizzards)? Yes X No

d. Other-Name

Q. Temperature Conditions

1. Ambient outside hottest 100 °F.

2. Ambient outside coldest -5 °F.

3. Engine-generator room hottest 110 °F.

4. Engine-generator room coldest 50 °F.

5. Inside switch gear hottest 84 °F.

6. Inside voltage regulator or ambient near voltage regulator hottest 100 °F.

7. Ambient at exciter hottest 100 °F.

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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>yes</u>	<u>not different</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>2 years</u>	<u>not different</u>
b. 3-6	<u> </u>	<u> </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>Combination as required</u>	<u>not different</u>

4. Licensing required

	<u>Existing</u>	<u>Suggested</u>
a. State	<u> </u>	<u> </u>
b. Federal	<u>yes</u>	<u>not different</u>
c. Utility or self	<u> </u>	<u> </u>
d. None	<u> </u>	<u> </u>

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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 ³)
N/A	N/A
N/A	N/A
N/A	N/A
N/A	N/A
N/A	N/A

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?
N/A

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

V. Have repetitive mechanical failures occurred in any component part or subsystem of the engine, generator, or switch gear, etc.?
Yes _____ No X

If yes, then which part or subsystem? N/A

How many failures? N/A

Give nature of failure. N/A

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

Give brief reasons for the answer. TMI has enough qualified people and thorough enough procedures to adequately maintain the diesel generators.

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

Preoperational test Date _____

	Engine Serial No.	Surv. Testing & Maintenance Hrs. No Load	& Loaded	Emergency and Other Service Hrs.	Total Hours
Diesel B	38D870076 TDSM 12	UN	UN	UN	414
Diesel A	38D870073 TDSM 12	UN	UN	UN	438

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
25	UN	125

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

- a. Starting date of surveillance testing (OL date) 9/2/74
- b. Periodic test interval Monthly
- c. Total number of surveillance tests performed M=212
- d. Total number of test failures 1

failure to start 1 failure to accept load 0
 failure to carry load 0 failures due to operator error *
 failure due to equipment not being operative during emergency conditions 0

- e. Supply a copy of the surveillance test procedures with this completed questionnaire. See 1303-4.16 and 1303-11.10 attached.

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Additional Comments

~~None~~

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.

The present monthly testing program is too extensive in that the machinery is "Tested to death". If these tests were eliminated, fewer corrective maintenance requirements would be generated. The Annual Inspection is deemed necessary and desirable.

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