UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

MAY 30 1979

MEMORANDUM FOR: H. L. Ornstein, Technical Specialist, Office of TA/EDO

THRU: G. Lainas, Chief, Plant Systems Branch, DOR

FROM: F. Clemenson, Plant Systems Branch, DOR

SUBJECT: EMERGENCY ONSITE DIESEL GENERATORS

This is in response to your verbal request on May 2, 1979, regarding my knowledge of problems associated with the diesel engine lubrication system and their turbochargers. In particular, you cited an April 27, 1979 letter from Northern States Power Company (Monticello 50-263) regarding some tests recently conducted by Electro-Motive Division (EMD) of General Motors Corporation. It appears that there is a particular time interval following the completion of a test run where, should the engine be again subjected to a rapid start, the turbocharger thrust bearings may not receive sufficient lubrication. This would result in cumulative bearing damage that would result in the failure of the turbocharger.

I contacted Harvey Hanners (University of Dayton Diesel Engine Consultant) and asked for his opinion regarding this problem. His response was that the problem was not that unusual and he proceeded to describe two different methods he has employed in the past to overcome the problem. Neither method, I suspect, involves extensive modifications. It will be of interest to find out what modification will be recommended by EMD.

The Plant Systems Branch considers the information contained in the Northern States Power Company's April 27, 1979, letter of sufficient importance that we intend to recommend that an I&E Circular be sent out on the subject. We have also alerted the Monticello operating reactor project manager of the letter and requested that he keep us informed on the modifications.

My interest in the diesel engine turbochargers started around June 1975 after reading a Nuclear Safety Information card because of possible similarities in reported events at James A. FitzPatrick and Surry Unit 1 as well as some operating limitations cited by Beaver Valley Unit 1. It eventually was established, for at least one make of diesel engines (General Motors), that there was a decided limitation to the life expectancy of some vital engine

MAY 30 1979

components when operating at rated speed at light or no loads. EMD was reluctant to give me any information when I contacted them by telephone in August 1975. Based on their lack of responsiveness, it was then decided to work through an operating reactor plant. We contacted Nine Mile Point Unit 1 (Niagara Mohawk Power Corp.), which we were given to understand had GM diesels like James A. FitzPatrick. Through them we obtained an unofficial copy of the attached GM letter dated June 26, 1975. It states that after 200 hours at synchronous speed and no load it is recommended that the turbocharger be replaced.

The University of Dayton report, NUREG/CR 0660, also contains a letter, in Appendix F from EMD of General Motors which discusses their improved turbocharger conversion kits for their engines (copy enclosed).

As indicated in the Monticello letter, inadequate lubrication creates problems. Conversely a long prelube period also creates problems such as exhaust fires. Enclosed is a copy of the University of Dayton recommendations relating to the lubrication system.

The NUREG/CR 0660 report was sent to all operating reactors and utilities having a Construction Permit. I hope it is read and voluntarily implemented where applicable. In my view most of their recommendations are down to earth, practical and in most cases they will not have a significant adverse impact on the plant.

Fred Clemenson

F. Clemenson
Plant Systems Branch
Division of Operating Reactors

Enclosures:
1. EMD - GM letter dated June 26, 1975
2. Recommendations from NUREG/CR 0660
3. EMD-GM letter dated October 18, 1978

cc w/enclosure:
V. Stello
D. Eisenhut
R. Vollmer
G. Lainas
E. Adensam
F. Clemenson

Enclosure 1

Reference 3

Electro-Motive
Division of General Motors Corporation
La Grange, Illinois 60525 (312) 485-7000

June 26, 1975

MEMORANDUM

SUBJECT: ENGINE LIGHT LOAD OPERATION
NUCLEAR STANDBY UNITS

Internal combustion engines operate most reliably at the rating for which they are designed. This is true of EMD diesel engines as well as those of other manufacture.

At extended light load operation, "souping" can be expected to occur with any diesel engine, including those built by EMD. The term "souping" refers to an accumulation of lube oil in the exhaust system due to light load operation. Depending upon the amount of "souping" that has taken place, an exhaust fire could result when the engine is suddenly loaded.

If an engine has been running lightly loaded it can be "cleaned out" by following the recommendations listed below:

a. Operation at synchronous speed at loads between 0 and 20%: After three (3) hours of operation, run the engine at a minimum of 40% load for a minimum of 30 minutes to clean out exhaust stacks.

b. Operation at idle speed (440 - 520 RPM): After four (4) hours of operation, run the engine at a minimum of 40% load for a minimum of 30 minutes to clean out exhaust stacks.

At synchronous speed and no load, a 200 hour accumulative time limit has been placed on turbochargers in existing nuclear installations. After 200 hours of no load this component should be replaced.

Reference 3



The "shelf life" limit of the head to liner seals is five (5) years from the time of engine build-up. Build-up date can be determined from the engine serial number; for example, 71-J1-1010 means the engine was build in September, 1971 (i.e. J is ninth in alphabet excluding "i" and September is ninth month).

The preceding information has been established for nuclear standby engines only. This information represents Electro-Motive's current knowledge and experience. As future improvements are made to the engine, these criteria may be modified.

G. H. Coleman
Manager Reseller Sales

/et

Enclosure 2

1. Pre-Lube -- All Engine Starts Except True Emergency

It is recommended that pre-lube periods for general engine lubrication of a maximum of approximately 3 to 5 minutes be required preceding all engine starts except for an actual or simulated emergency start. Pre-lube periods of more than approximately 5 minutes are to be only by specification or recommendation of the particular engine manufacturer. (Various engine problems may be caused by excessively long pre-lube periods.)

2. Pre-Lube -- All Engine Starts Including Actual or Simulated Emergency Starts

A long "drain down" concurrent with an engine shut down of several days to several weeks can result in a nearly empty engine lube oil piping system. As much as 5 to 14 seconds may elapse from the start of cranking until full lube oil pressure is attained even though full engine speed may simultaneously be reached in less than 5 seconds. The resulting momentary lack of lubrication may result in metal-to-metal contact in bearings such as the engine crankpin bearings and turbocharger bearings causing damage in "pulling" or "wiping" the bearing surface producing incipient or actual failure. Immediate full speed with nearly dry bearing surfaces is a much more severe condition than a more gradual speed increase. However, the emergency condition of readiness does require immediate full speed for generator service. Starting of the pre-lube oil pump at the same instant as the start of any engine cranking under all circumstances would add to the oil flow displacement of the engine lube oil pump and would expel the air and establish the necessary oil film in the bearings as quickly as possible.

An electrically driven pre-lube oil pump accelerates to full speed quite rapidly with full delivery while the engine

driven pump acclerates more slowly with the engine and with the correspondingly slower initial pumping rate.

Recommendations:

It is recommended that the engine pre-lube pump be started by the same signal which initiates the cranking of the engine and be stopped when the engine stops cranking. An alternative approach would be to start the pre-lube pump by the same signal but stop the pump when the pressure in the engine lube oil header has achieved a predetermined level. In either case, the implementation of this recommendation should be carried out in close consultation with the respective engine manufacturer. On some engines, the pre-lube pump is an integral part of the engine lube oil heating system used while the DG unit is in the standby mode.

Enclosure 3

ELECTRO-MOTIVE

Electro-Motive Division General Motors Corporation LaGrange, Illinois 60525 (312) 387-6000

October 18, 1978

Mr. Harvey W. Hanners
Senior Research Engineer
University of Dayton
300 College Park Ave.
Room 163A
Dayton, OH 45469

Dear Mr. Hanners:

Your October 5 letter asks for confirmation of our information given in our phone conversation approximately a week ago having to do with the conversion of certain turbochargers to the heavy duty gear type. You mentioned particularly 20 cylinder engines.

While many, in fact most, of the engines in emergency standby service at the various nuclear power plants are 20 cylinder left-hand rotation engines, some of these engines are 16 and 12 cylinder and a few are right-hand rotation. The right-hand rotation engines are used where there is a tandem installation with two engines driving a single generator. I am, therefore, including information to cover all of these various types.

A description of the job that would be done and an estimated cost of it for each of the different types are as follows:

Section 1. Conversion of 12, 16, and 20 cylinder turbos from E4 (Industrial, Standard Gear Ratio) left-hand rotation to E9 (Industrial, Heavy Duty Gear Ratio) left-hand rotation.

1A. Gear Conversion Only: $ 9550.

Includes renewal of complete turbine wheel assembly, clutch assembly, carrier shaft assembly, idler gear, idler gear stubshaft and retainer plate, carrier drive gear, and turbine inlet scroll support. Also includes modification to idler gear support and redoweling.

1B. Turbo Upgrade: $ 575.

This includes modifications to bring turbo up to latest E9 specifications, such as pressurized exhaust duct drain arrangement, "no spin" compressor bearing, and chrome sealing rings.



362 221

Section 1 (Con't)

1C. Turbo Basic $ 1400.

This includes disassembly, cleaning, inspection, reassembly with new gaskets, seals, nuts and bolts, turbo test and paint.

Since we cannot sell the gear conversion only, as listed in 1A, the total estimated conversion sell price would be the sum of 1A., 1B., and 1C., or $11,525.

1D. Unit Exchange Repairs: $ 3000.

Many of the elements usually included in average turbo repair have already been considered in above conversion breakdown, including turbine wheel and clutch. Additional repairs required will depend on condition of Bad Order Return. However, it is estimated that an additional $3000. will cover "normal" remanufacture for components not previously covered, such as turbine inlet scroll, both diffusers, nozzle ring, impeller cover, and main doweling components. Severe damage to main doweling components will elevate charges past $3000.

Total Unit Exchange charge for remanufacture and conversion is estimated as follows:

Conversion Estimate = $11,525.
Estimated Remanufacture Range = $ 500. to $ 3000.

Section 1. Total = $12,025 to $14,525.

Section 2. Conversion of 12, 16, and 20 cylinder turbos from E5 (Marine, Standard Ratio) right-hand rotation to E5 (Marine, Heavy Duty Ratio) right-hand rotation.

2A. Gear Conversion Only: $ 8900.

Same as 1A., except does not include idler gear renewal, idler gear support modification, or redoweling.

r. Harvey Hanners

2B. Turbo Upgrade: $ 100.

Includes modification to exhaust duct for pressure drain arrangement.

2C. Turbo Basic: $ 1400.

Same as listed for 1C.

Total estimated conversion sell price $10,400.

2D. Unit Exchange Repairs: $ 3,000.

Same estimate as 1D.

Total unit exchange charge for remanufacture and conversion is estimated as follows

Conversion Estimate = $10,400.
Estimated Remanufacture Range = $ 500. to $ 3,000.

Section 2. total = $10,900. to $13,400.

Please keep in mind that these are not firm prices. These estimates should be considered reasonable until April 1979.

I am also attaching a sheet which is entitled simply "Turbocharger" which lists in the first column the various types of engines and it shows in the other columns part numbers for new and unit exchange turbochargers of both the standard gear and heavy duty type. From this listi[illegible]nyone owning an engine of this kind can determine which turbocharger he no[illegible] by finding that part number in the second column can refer then to the fina[illegible]olumn showing the utex number of the heavy duty gear turbocharger that will replace what he now has.

Customer should order the heavy duty gear utex number that he wants from our Rebuild Dept. here at LaGrange and specify that he will be returning the turbo-charger under whatever number his turbocharger now bears. This part number is on a nameplate on the turbocharger. At the same time he should order a new drive gear if he needs one and the information for that is also given on this same table

EMD will sh[illegible]m the turbocharger he has ordered and once he has this on hand on his property he can then make arrangements to trade the replacement turbo for the one now on the engine, returning the removed turbo to the EMD Rebuild Dept. His invoice, as explained in the cost estimates above, will be partially determined by the condition of the turbo that he returns.



362 224

October 18, 1978

Mr. Harvey Hanners

The warranty on any unit exchange turbocharger is for one year starting the day it is placed in service.

Your statement that the gear drive is understood to be capable of carrying the turbocharger drive load with the engine at no load and full speed, as currently practiced in nuclear power plants, is essentially true. There is an estimated time limit of 2000 hours running under these conditions. However, with the way nuclear power plant protection engines are operated, this number of hours represents a good many years of operation.

I would like to state one more time that EMD does not recommend the operation of an engine at full speed no load whether or not it is equipped with heavy duty turbos. Such operation is not only hard on the turbocharger, but will affect the life of many other parts in the engine also. We continue to feel that efforts must be made to eliminate the need for such operation, particularly when the engine is in such critical service as these are.

If there is any other information I can furnish, please advise.

Very truly yours,

W A Gardner

W. A. Gardner, Assistant
General Service Manager
Marine & Industrial

WAG/pl

Encl.



362 225

TURBOCHARGER

| TYPE OF ENGINE | PRESENT NEW | (STANDARD GEAR) UTEX | FUTURE NEW | (HEAVY DUTY CLU UTEX |
|---|---|---|---|---|
| 12-645 LH | 8[illegible]6855 | 8413708 | 8491383 | 8492060 |
| 16-645 LH | 830[illegible]223 | 8372778 | 8491823 | 8492861 |
| 20-645 LH | [illegible]36072 | 8377586 | 8491825 | 8492062 |

NOTE: THE PRESENT 8419154 DRIVE GEAR MUST BE REPLACED BY 8449231 WHEN ANY OF THE ABOVE TURBOS ARE CONVERTED

| | | | | |
|---|---|---|---|---|
| 12-645 RH | 8369663 | 8379297 | 9336195 | 9084531 |
| 16-645 RH | 8363760 | 8379295 | 9084533 | 9087158 |
| 20-645 RH | 8374986 | 8380125 | 9085863 | 9093612 |

NOTE: CONVERSION OF RH ENGINE TURBOS DOES NOT REQUIRE DRIVE GEAR REPLACEMENT, THEY ARE NOW EQUIPPED WITH 8449231

362 226