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January 31, 1986

Mr. Jerry Hulman, P-822
Chief Plant Systems Br. DBL
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Visit to Fermi II Nuclear Power Plant - Order Number DR 86-0618

Dear Jerry:

Enclosed is my report on the visit to Fermi II with Mr. Jack Kudrick and Mr. Allen Notafrancesco to meet with the Detroit Edison representatives.

The meeting was very good but there were some problems needing more clarification.

My statement for the work and visit is also enclosed. If you would give it to the proper people it would be appreciated.

Sincerely yours,

Paul

Paul J. Louzecky

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VISIT TO THE FERMI II

ENERGY CENTER OF DETROIT EDISON

INTRODUCTION

A visit was made on January 24, 1986 to the Detroit Edison Enrico Fermi II Nuclear Power Plant.

The purpose for this visit was for NRC representatives to meet with the Detroit Edison people, their consultants and Fairbanks Morse (Colt Indus .es) service representatives. Detroit Edison and the others were to review the Fairbanks Morse Opposed piston engine problems, and explain their proposed corrective action.

FAIRBANKS MORSE MODEL 38TD8-1/8 OPPOSED PISTON ENGINES

COMMENTS ON MEETING AT FERMI II

DRY STARTS

Based upon my engine experienced and upon examination and assessment of the failed upper crankshaft bearings, I would expect some upper crankshaft bearing degradation if and when the engine is started without lubrication of the upper crankshaft, often called a dry start.

A Dry Start,sometimes called a Fast Start with no pre-lubrication, is one where the upper crankshaft bearings receives no oil except that provided by the one gallon emergency oil reservoir. The pre-lubrication reservoir has a one gallon capacity which is too small to provide sufficient oil to all the upper crankshaft bearings.

If a dry start is initiated shortly after an engine shut down, say one to eight hours, there is probably sufficient residual oil remaining on the bearings. If, however, a dry start is initialed in a week or a month since engine operation, it is my opinion that some scuffing of the dry bearings could be expected.

It is understood that a number of dry starts have been run on the Fairbanks Morse engines with apparently no bearing problems. However, no information was made available on the engine operation or down time between the dry starts.

The amount of residual oil on the bearings depends upon the way the engine was run before shut down. Was it stopped at high load so that the heat soak would drain much of the hot oil from the bearings or was it idled and cooled before shut down allowing some of the oil to remain on the bearings? Answers to these questions and the time after shut down before running additional dry start tests would help explain at least part of the dry start problem.

As mentioned, the upper crankshaft bearings of these opposed piston engines are especially critical. In a dry start the upper crankshaft bearings only receive oil from the one gallon reservoir.

The keep warm oil pump only lubricates the lower crankshaft bearings. Lubricating the upper crank would allow some excessive oil to run down the cylinder and into the combustion space.

BREAKING-IN THE BEARINGS

These engine bearings have no babbitt overlay to help

break them in or help them during the critical starting period.

Inorder to try and wear in the bearing surface, Fairbanks used an abrasive run in compound. The abrasive particle size, as measured by Dr. Lawrence Leonard of the Franklin Research Center, was about .002 to .005 inches in size. The composition of this material was found to contain magnesium, aluminum, silicon, cadmium and other material.

It is my opinion that this compound was sufficiently abrasive to scratch both the bearing shell and journal, destroying the bearing surface. Scratched bearings and journals were noted during previous visits to the plant.

MINIMUM OIL FILM THICKNESS

Dr. Lee Swanger of Failure Analysis Associates reported that the minimum oil film thickness of No. 4 main bearing was .000133 inches or 133 micro inches. If the mean surface roughness for both journal and bearing is about ten micro inches, then the largest dirt particle that can pass through the bearing is about .000090 inches or 90 micro inches. This condition means that the abrasive break in compound, which is .002 to .005 inches in size or more than twenty times greater than the minimum oil film thickness, will scratch or scuff the bearings and journals and destroy the ability of the bear ing to develop an oil film and to carry its load. Therefore, the use of this breakin compound raises some questions.

OIL FILTER

The oil filter was reported to have a filtering capacity of five microns. This means that the dirt in the oil less than .00020 inches may not be filtered out. The dirt that can pass through the filter is twice as great as the oil film thickness, so even the dirt passing through the filter can scratch the bearings. For this reason it is important to keep the oil clean

BEARING ALIGNMENT AS CHECKED WITH A MANDREL

Some questions were previously raised about the bearing alignment. I understand that it is standard practice to check the alignment and the upper bearing cap clearance with a mandrel. The clearance as reported varied from about .003 to .007 thousands. Inorder to correct this variation an adjustment was made to the main bearing caps. When corrected the clearance was about .005 inches for all the bearings. Because the upper caps carry the high bearing load, correcting the alignment is good. However, correcting the alignment also changes the bearing crush, another very critical item. Will the change in crush change the bearing operating condition?

CHECKING THE OPERATION OF A BEARING WITH A .002 INCH THICKNESS GAGE

It was reported by the Fairbanks representatives that if a bearing shell fails it will tend to close in and that if a .002 inch thickness gage can be inserted behind the shell at the split line the bearing has failed. There are, however,

some bearings near failure that have not closed in. Therefore it seems prudent to me to remove the main bearing caps and look at the shell bearing surface in the caps directly and also look at the journal to see if the bearing can develop an oil film. This inspection is a judgment condition as all bearings will show some scratching.

Removing the upper main bearing caps for a bearing surface inspection does not constitute damaging the bearing. The cap is lifted off and the bearing inspected. If any damage has been done to the bearing when lifting the cap it should be noticed by the inspector.

If no visual inspection is planned then I think the upper bearing shell temperatures should be measured with suitable alarms inorder to minimized future problems.

If the bearing shell had a babbitt overlay there would be a good possibility that the bearing could heal. In my judgment Aluminum with 6% tin does not heal readily. Usually the aluminum wipes the journal and failure results.

The Glacier people (Glacier Metal Company, Ltd.) an engine bearing manufacturer in England, recognized this problem so their solid aluminum bearings contain 20% tin.

Questions were raised that removing the cap disturbes the bearing shell. Calculations show that the shaft can move longitudinally as much as .100 inches from hot to cold, so the crankshaft journal surface moves with respect to the bearing surface. It has been my experience that if a bearing and journal are good they don't care where they ride on these surfaces.

On larger engines it is common practice to roll out a bearing shell for inspection. If the shell is good it continues to operate after it is reinstalled.

Also, on these large engines it is commoon practice to measure the main bearing temperature. On some of the engines a probe with a fusable plug is mounted on the bearing shell. At some set higher than operating temperature the fusable plug melts if trouble develops and an air signal shuts down the engine. In an emergency the air signal is disconnected. Possibly this type of temperature indicator or thermocouples could be installed to indicate the bearing temperatures and warn of a failure.

PROPOSED TEST PROGRAM

The proposed 40 hour extended wear in test program followed by a 100 hours continuous load test and the 20 slow starts and 10 fast starts is OK but the problem it seems to me is one of upper bearing lubrication and dry starting. This part of the problem has not been addressed. Also, the oil reservoir capacity has not been addressed. The reservoir capacity I think should be increased to, say, 5-7 gallons or a very definite upper crankshaft prelubrication program established. The program could include measurements of the upper shaft main bearing temperatures.

OIL ANALYSIS AND OIL

On large engines it is common practice to analyse the engine lubricating oil for dilution, change in oil characteristics and wear metals. An oil analysis was shown to me at a previous visit to the plant. The results showed that the oil that was analysed looked good. However, some questions were raised. Was the oil taken from the engine oil system after it had been running for some time? Taking oil samples this way reduces the chances of the heavier wear particles from settling out. Also, before analysing the sample it should be shaken inorder to make the test representative of the oil.

Analyzing an oil shows how it is disintegrating over time, but a bearing can fail anytime.

The sample, therefore, may not warn of a failure that happens quickly. Reading the bearing shell temperature is a better way to monitor bearings.

Engine oils have many different properties. For these engines, using an oil with good lubricity and metal wettable characteristics is desirable.

Paul J. Louzecky

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January 31, 1986