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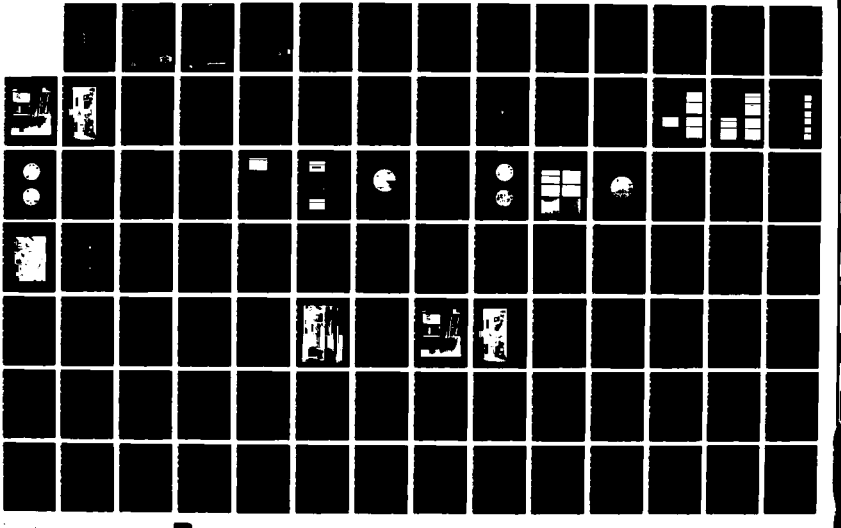

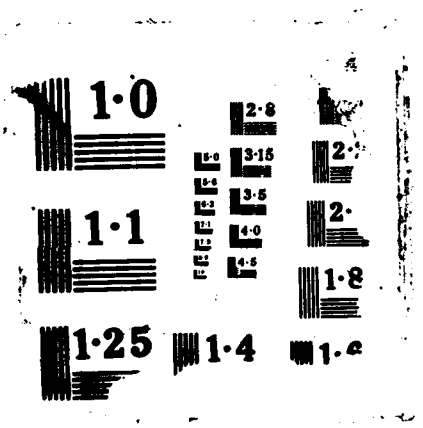
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NONDESTRUCTIVE EVALUATION AND ENDURANCE TESTING OF REFURBISHED T53 ENGINE BEARINGS P/N 1-300-015-(02/04)

FINAL REPORT
SwRI Project 17-5607-821/822

Prepared for
U.S. Army Aviation Systems Command
St. Louis, Missouri 63120

Performed as a Special Task for the Nondestructive Testing Information Analysis Center under Contract No. DLA900-79-C-1266, CLIN 0001AK.

December 1987

SOUTHWEST RESEARCH INSTITUTE
SAN ANTONIO HOUSTON

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AD-A194 932

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Nondestructive Testing Information Analysis Center

June 10, 1988

Defense Technical Information Center
ATTN: DDA-C
Cameron Station
Alexandria, VA 22304

Subject: Replacement Copy of NTIAC Special Task Final Report, Contract No. DLA900-79-C-1266

Gentlemen:

Enclosed for your files is a replacement copy of NTIAC Special Task Final Report, "Nondestructive Evaluation and Endurance Testing of Refurbished T53 Engine Bearings, Part No. 1-300-015(02/04)," CLIN 0001AK, SwRI Project 17-5607-821/822. The original report sent to you on May 10, 1988 contained an error and should be replaced with the enclosed copy. Please destroy the earlier version.

We apologize for any inconvenience and thank you for your cooperation.

Very truly yours,

Frank A. Iddings
Director of NTIAC

FAI:mfa
Enclosure

[redacted]

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NONDESTRUCTIVE EVALUATION AND ENDURANCE TESTING OF REFURBISHED T53 ENGINE BEARINGS P/N 1-300-015-(02/04)

Prepared by
WILLIAM D. PERRY
JOHN C. TYLER

FINAL REPORT

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Approved:

James L. Burch
Vice President
Instrumentation and Space Research

Unclassified

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19. ABSTRACT (*Continue on reverse if necessary and identify by block number*)

The primary program goal to requalify used bearings by regrinding the races and replacing the balls is briefly reviewed. Southwest Research Institute's task of inspecting the bearings before and after regrinding and endurance testing the refurbished bearings are briefly discussed. Five hundred rejected used T53 engine bearings, part number 1-300-015-(02/04), were inspected utilizing the CIBLE (Critical Inspection of Bearings for Life Extension) system. After the initial inspection was complete, the bearings were shipped to ITI (Industrial Techtonics Incorporated) to be refurbished. The refurbished bearings were returned to SwRI where they were again inspected utilizing the CIBLE system. The results of the CIBLE inspections, before and after regrinding, are presented. Twenty-eight refurbished bearings and 10 new bearings were endurance tested to determine if the refurbished bearings performed as well as new bearings. Conclusions and recommendation, based upon inspections and endurance testing performed at SwRI, are presented.

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Unclassified

Forward

The work reported herein was conducted under a program sponsored by the United States Army, TSARCOM. The authors express their appreciation Martin Joseph and the personnel TSARCOM, AVRADCOM, and the CCAD bearing shop for their participation and cooperation in this program. We are grateful to Mr. Hans R. Signer, Chief Engineer at ITI, and all the personnel at ITI for their contributions to this program. The authors would like to recognize the significant contribution by Mr. C. R. McGinnis, who was responsible for coordinating the bearing inspections, data acquisition and data analysis for this program. We would also like to thank Mr. B. B. Baber for his contribution to the endurance testing effort and to Mr. George Matzkanin, Project Manager of the Nondestructive Testing Information Center at SwRI, under which this program was funded. Finally, we would like to thank Mr. Bob Barton for his contributions and guidance during the course of this program.

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I INTRODUCTION

A Background

In 1981, the U.S. Army Troop Support and Aviation Materiel Readiness Command (TSARCOM) initiated a program to determine if "Rejected Bearings" from the T53 engine could be qualified for reuse by regrinding the inner and outer races, refurbishing the cage and replacing the balls. Hopefully this would yield a reworked bearing which would be as good as new. To accomplish this, a multi-task program was undertaken which required the coordinated efforts of TSARCOM, Corpus Christi Army Depot (CCAD), Southwest Research Institute (SwRI), and Industrial Techtonics, Incorporated (ITI). Figure 1 is a simplified process flow diagram showing the major tasks that were accomplished during this program. This report covers the work accomplished at SwRI which consisted of three major tasks:

1. Inspection of rejected bearings before regrind.
2. Inspection of reworked bearings after regrind.
3. Endurance testing of new and reground bearings to verify performance.

These bearings, part numbers 1-300-015-04 and 1-300-015-02, are radial contact bearings manufactured by Fafnir and New Departure. These bearings are interchangeable even though the internal construction is different.

B Inspection Equipment

Southwest Research Institute personnel utilized the CIBLE (Critical Inspection of Bearing for Life Extension) system to inspect all inner and outer races of the bearings before and after regrind. The CIBLE equipment provides a complete, integrated, nondestructive inspection methodology using multiple noncontacting sensors with precision tracking of individual probes. Accordingly, it is possible to correlate inspection results from several sensor channels, thereby providing a more complete definition of the size and location of the flaws. A rapid nondestructive examination of the active race surface is accomplished automatically under the supervision of a mini- computer. Two different NDE methods, Magnetic Perturbation Inspection and Barkhausen Noise Analysis, were used for this program. The CIBLE system is shown in Figure 2 and a detail description of the system is presented in Appendix A. The computer, video terminal, magnetic data recorder, power supply, and electronics are housed in the control console, while the cabinet at the left houses the bearing race inspection assembly. Figure 3 shows internal details of the race inspection assembly.

A set of precision fixtures and associated software are required for each bearing race configuration. Changing the system configuration for one type of component to another is simple and can be accomplished in approximately five minutes. Fixtures essentially

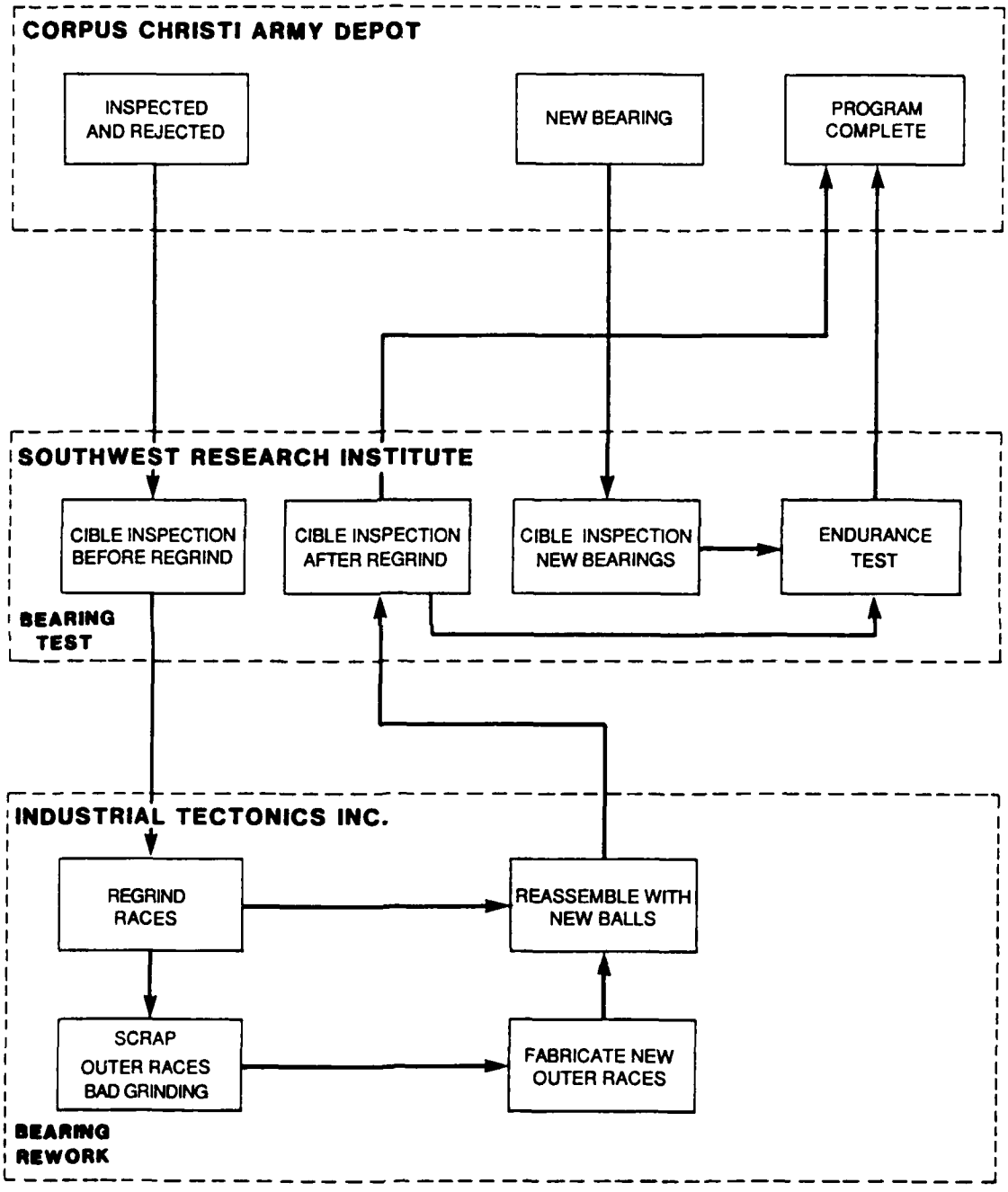

Figure 1: Process Flow Diagram

Figure 2: CIBLE System

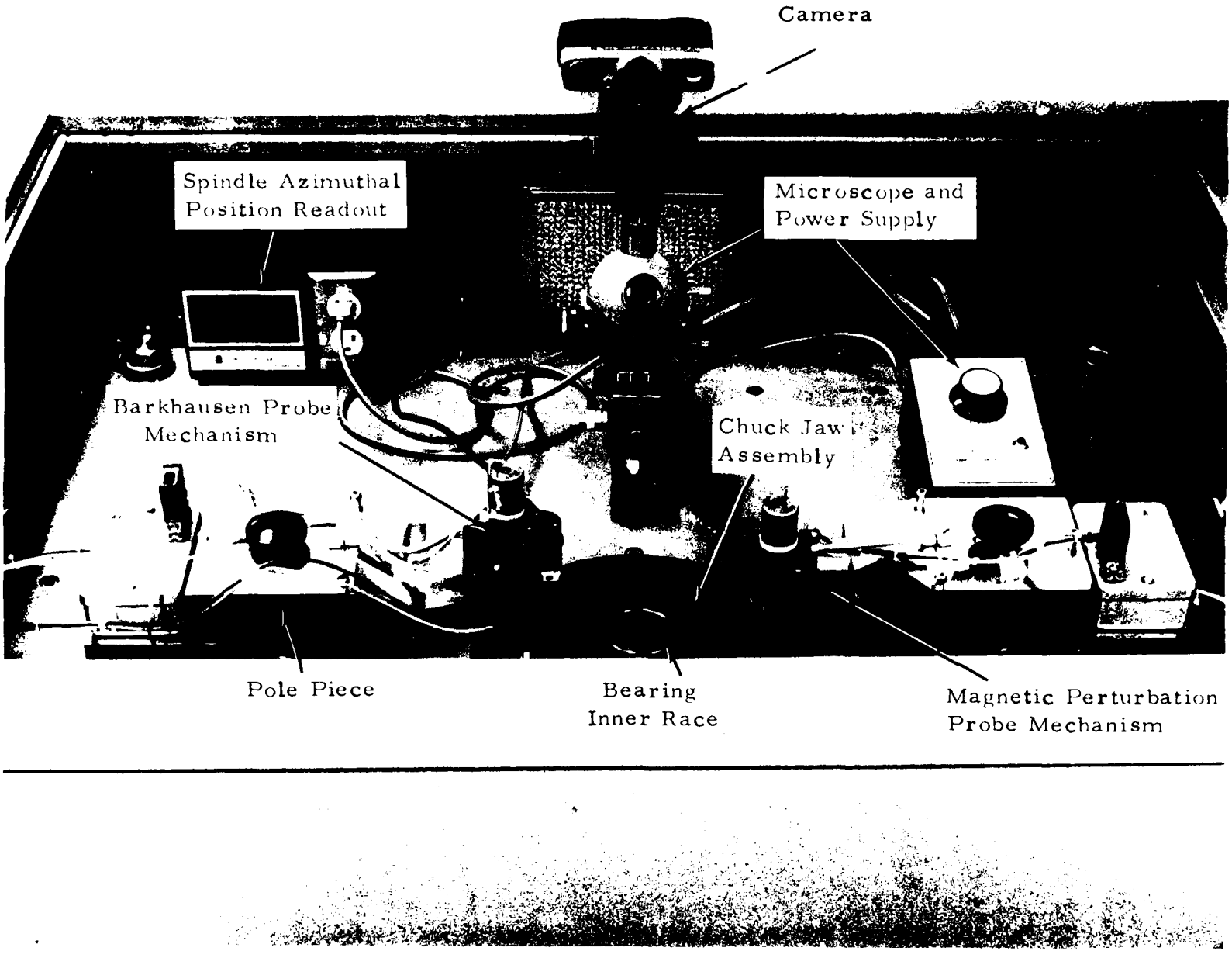

Figure 3: Internal Details of the Race Inspection Assembly

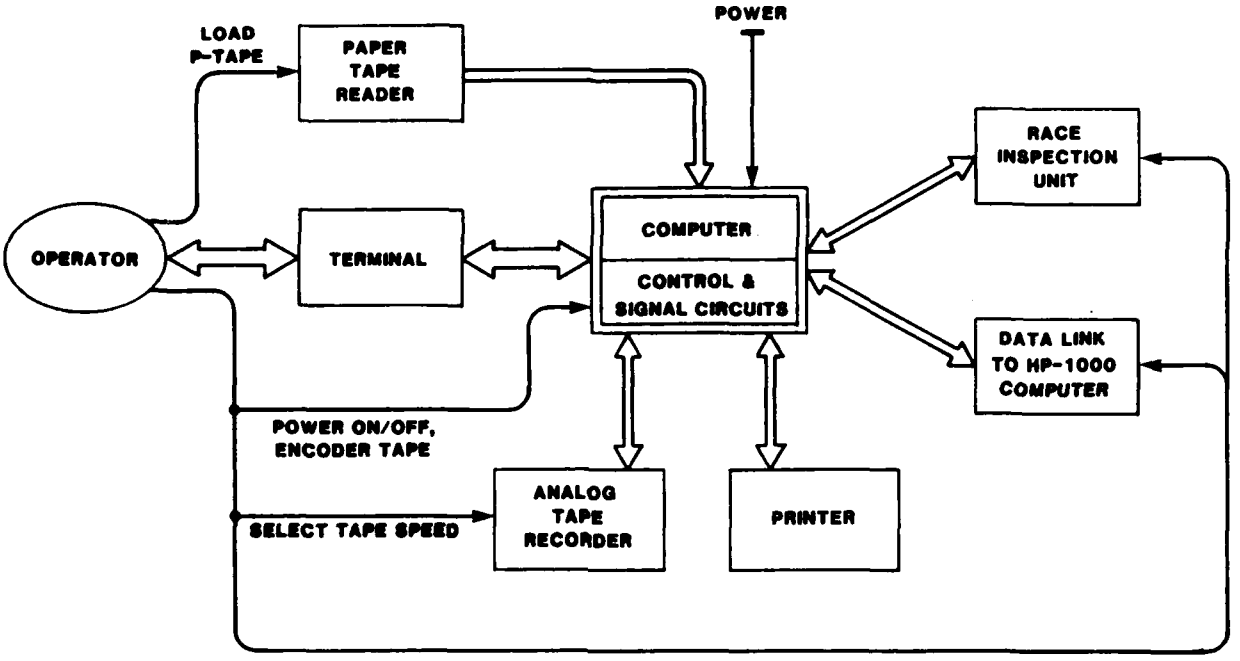

Figure 4: System Diagram - Function of the Operator

consist of a set of chuck jaws for positioning the bearing during inspection and a set of magnetic pole pieces to guide the flux to the inspection region. The pole pieces also support and precisely position the magnetic perturbation and Barkhausen probes which ride on an air cushion above the race surface. Stepper motors, under supervision of the computer, automatically index the probes to inspect the active raceway surface during high-speed rotational scans of the race. An optical sensor detects the location of a permanently engraved mark on a non-critical surface of the bearing race, and this mark is checked continuously by the computer to provide precise relational information of detected flaws. After the inspection is completed, the races are automatically demagnetized and flaw signature information, which was stored in the computer memory during inspection, is printed. For this program, the inspection data was also transmitted to an auxiliary (HP-1000) computer where the inspection results were entered into a master database. This database allows for rapid sorting and analysis of the large volumes of data required on this program. Auxiliary information about the bearing races such as service hours, Army serial numbers and comments about the race or inspection were manually entered into the same database. Figure 4 is a system diagram and the black lines indicate the routine functions of the operator.

CIBLE equipment features, and a concise summary of the inspections performed, are presented in Table 1. The Army's CIBLE system, which was used for this program, does not include the laser-scattered light inspection capability. This inspection technique was not utilized during this program. A small number of races were inspected with laser light using the SwRI CIBLE system to demonstrate the capability. The magnetic perturbation inspection examinations are capable of resolving tiny subsurface inclusions as small as 0.001 inch in diameter, which is far beyond the capability of other nondestructive inspection methods and can detect both surface and subsurface flaws. The Barkhausen Noise Analysis of residual stress measurement is a state-of-the-art development capable of sensing surface and subsurface stress changes and the associated material transformations which occur during extended severe loading of ball bearing components. This is the only known completely nondestructive method of sensing such stresses.

CIBLE

(Critical Inspection on Bearings for Life Extension)

AUTOMATED BEARING INSPECTION SYSTEM

FEATURES

- Computer Supervised and Controlled Inspection
- Rapid Fixturing Changeover for Different Bearings
- Computer Setup of Parameters for Different Bearings
- Computer Printout of Signal Locations
- Permanent Record on Magnetic Tape
- Diagnostic Printouts and Safety Interlocks

SPECIFICATIONS

Inspection Methods	Conditions Detectable	Scan Pattern
MAGNETIC PERTURBATION		
Radial Flux		
•High Field	Surface Pits, Inclusions,	
•Low Field	Spalls and Indentations	0.025-Inch Wide Circumferential Strips with 20% Overlap
Circumferential Flux		
•High Field	Subsurface Inclusions, and Spalls and Deeper Surface Anomalies	
•Low Field	Fatigue Damaged Regions and Indentations	12 to 60 Scans per Inspection Method Synchronized Scans
LASER-SCATTERED LIGHT		
Surface Anomaly	Surface Scratches, Pits, Spalls, and Indentations	
Surface Finish	Relative Surface Finish	
BARKHAUSEN NOISE		
	Relative Surface and Near-Surface Residual Stress Conditions	Programmed Sampling 0.050 x 0.050 Inch Regions 9 to 15 Locations
	Service Modification of Residual Stress	

Table 1: CIBLE Automated Bearing Inspection System - Features and Specifications

II SUMMARY OF WORK ACCOMPLISHED

The work accomplished at SwRI on this project consisted of three major tasks:

1. Task 1: Inspection of bearings before regrind.
2. Task 2: Inspection of bearings after regrind.
3. Task 3: Endurance testing.

The task of inspecting bearings before regrinding began by acquiring 500 used bearings from CCAD and cataloging bearing information which included manufacturer, serial number and number of service hours for each of the 500 bearing sets. Each bearing set consisted of an outer race, two halves of a split inner race, the ball cage and a complement of balls. After cataloging, the bearings were disassembled and all races were cleaned and inspected by the CIBLE system. A total of 500 used bearing sets were inspected (1000 inner races and 500 outer races) utilizing the automatic inspection sequence of the CIBLE system. Results of the automatic inspections, along with the cataloged information, were entered into the master database. Based upon the results of the automatic inspection, more detailed examinations were conducted on races with detected flaws. These efforts included the examination of flaw signatures, cross correlating flaw locations, surface photomicrography, surface replication and SEM micrography, as needed, on each race in which flaws were detected. Upon completion of the inspection and documentation for races from this group of rejected bearings, the bearings were reassembled, lubricated and shipped to Industrial Tectonics, Inc. (ITI) to be refurbished by regrinding the races and fitting each bearing with oversized balls. During the regrinding, 197 outer races were damaged and replaced with new outer races. All races were rematched. Since all the bearing components could not be refurbished, only 444 completed reground bearings were returned to SwRI to be inspected.

Task 2 consisted of reinspecting the reground bearing components utilizing the CIBLE system. All reground races, including new outer races which replaced outer races that were destroyed during the refurbishment, were inspected utilizing the automatic inspection sequence of the CIBLE system. Again, detailed examinations were conducted based upon the results of the automatic inspection. All inspection results were entered in the computer database and correlation studies were performed to determine if a detected flaw matched with a flaw which had been detected prior to regrind. Significant results have been obtained which established that very critical flaw conditions can pass unchanged through the regrinding process and still exist in the refurbished bearing.

After inspection of the reground races was complete, a sample group of bearings were selected for endurance testing. The object of these test was to determine if the endurance performance of the reground bearings was as good as new bearings. The

selection of bearings for testing was based upon the inspection results, manufacturer, and service hours. A selection criteria was used to assure that this group of bearings was representative of the total group of reground bearings. Ten new bearings of the same part number were also inspected by the CIBLE system and endurance tested to allow for a direct comparison of endurance results between new and reground bearings. A total of 38 bearings were endurance tested at a speed of 24,000 rpm and a load of 3,914 lbs thrust.

During the course of this program, an enormous amount of data was gathered. This data includes an estimated 5,000 photographs of flaw signals and the race surface at flaw locations. These data files which are too volumous to include with this report are on file at SwRI. To facilitate handling data, a summary of the results of each task has been entered into the master database on the computer. This master database contains information as to manufacturer, initial inspection results, dimensional changes of bearings during regrind, and inspection results of bearings after regrind. The database also includes information on service hours and a cross index of bearing race mates prior to regrind and after regrind. After the completion of the endurance testing, all bearing components were returned to CCAD.

Subsequent sections of this report present, in detail, the work accomplished and the results obtained which have been briefly summarized above.

III BEARING RACE INSPECTION

The program to qualify the process of reworking bearings by regrinding races required careful inspection and documentation of the candidate bearings before and after rework. The results of these inspections were compared to determine the effectiveness of the rework process.

A Bearing Race Inspection Before Regrind

Army personnel at CCAD bearing rework facility selected 500 reject bearings as candidates for this program. These bearings, P/N 1-300-015 (02/04), are used in T53 turbine engines. The group of 500 races consists of bearings from two manufacturers, Fafnir and New Departure. These bearings were received at SwRI as rejected assemblies. Each assembly consists of a two- piece split inner race, outer race, cage, and ball complement. Many assemblies were missing balls and some cages were missing, but all had a complete set of races.

When the bearings were received at SwRI, each set of races was assigned a SwRI number and logged into the bearing database. Each assembly was disassembled and cleaned. The parts were segregated into groups: Fafnir inner races, Fafnir outer races, New Departure inner races, New Departure outer races, and ball-cage assemblies. The ball-cage assemblies were stored with identification. All races were checked for identification markings; if missing, the identification information was added. A reference line was scribed on the outside of each race to provide an absolute azimuthal reference for locating the position of detected flaws.

The races were inspected as groups since each type of race required a different set of inspection fixtures and/or inspection parameters. The Fafnir and New Departure races required different inspection parameters because they were internally different. Although the bearing from the two manufacturers are interchangeable, the Fafnir bearing has a larger pitch diameter and one additional ball. These assemblies are angular contact bearings designed to take both axial and radial loads. Figure 5 shows the load track in relationship to the inspection tracks of the CIBLE system for both the Fafnir and New Departure bearings.

Information for each bearing race was added to the bearing database to insure complete documentation on each race. Table 2 is a list of the information stored in the database for each race. After completing the before regrind inspections, the database contained 1500 sets of data.

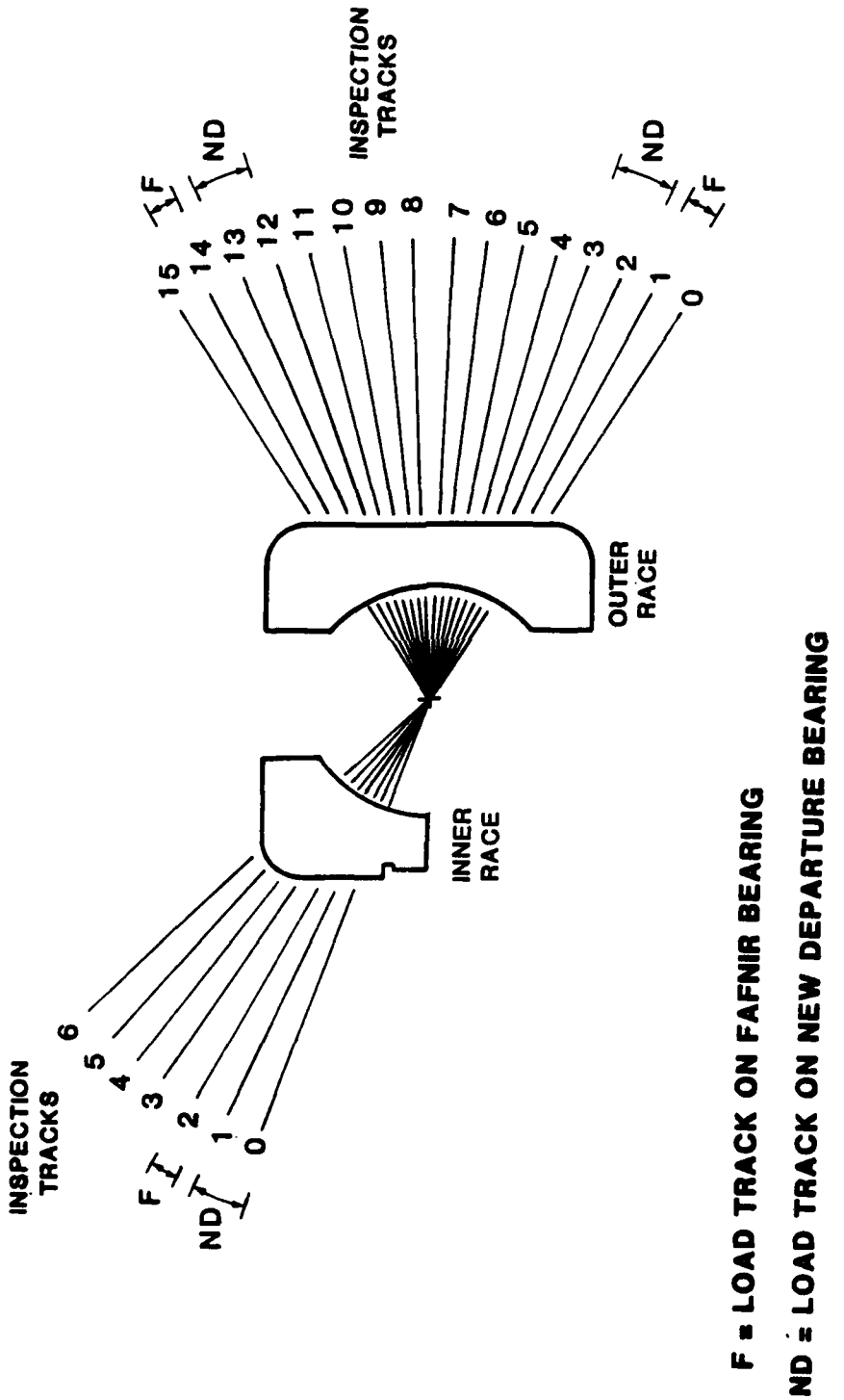

Figure 5: Load Tracks for Fafnir and New Departure Bearings, P/N 1-300-015-04 and P/N 1-300-015-02

BEARING DATA BASE

The data base contains the following information on each race:

SwRI I.D. Number	(Number)
Army Serial Number	(Number)
Rework Code	(0 Not Reworked, 1 Reworked)
Rework Manufacturer	(Name)
Service Hours	(Number)
Race Code	(Before Rework: 0-Inner, 2-Inner, 4-Outer) (After Rework: 1-Inner, 3-Inner, 5-Outer)
Manufacturer	(Fafnir or New Departure Hyatt)
Number of Flaw Indications Magnetic Perturbation Circumferential	(Number)
Number of Flaw Indications Magnetic Perturbation Radial	(Number)
Number of High Stress Indications by Barkhausen	(Number)
Number of Flaw Indications Laser Light	(Number)
Inspection Date	(Year-Month-Day)
Comments	(Any Operations)

Table 2: List of Information Stored in Database for Each Race

Each race was inspected using the automatic CIBLE inspection sequence which consisted of five inspections:

- CH (Magnetic Perturbation Circumferential High Field Inspection)
- CL (Magnetic Perturbation Circumferential Low Field Inspection)
- RH (Magnetic Perturbation Radial High Field Inspection)
- RL (Magnetic Perturbation Radial Low Field Inspection)
- BK (Barkhausen Noise Analysis Stress Inspection)

The results of the inspection are reported as a printout of the flaw indications for each type, the scan track, the azimuthal location relative to the reference mark on the race and the azimuthal location relative to the CIBLE system reference. Examples of the printouts are shown in the upper left hand corner of Figures 6, 7 and 8. All significant flaw indications were then documented with photographs of the signal traces and photomicrographs of the race surface at the point of detection. Figures 6, 7 and 8 are examples of this documentation. These figures show the correlation of the automatic printout, photographs of the signals, and microphotographs of the surface. In Figures 6 and 7, each flaw indication has been assigned a letter, a photograph showing high field circumferential and radial signal traces along with the photomicrograph of the race surface have a corresponding letter. The arrows indicate the signal which produced the alarm. Note that in examples B, D, and F, no flaw is visible at the surface, but the large circumferential signal indicates a subsurface flaw which may not be removed by regrinding. Figure 8 shows an example of a bearing with abnormal Barkhausen inspection signals which indicates a change residual stress. This is of interest since it was not known whether the process of regrinding would remove this abnormal stress condition.

Figure 9 shows the number of races with each type of magnetic perturbation high field inspection results. Races with CH signals have flaws which are most likely subsurface while races with both CH and RH indications have surface flaws which have some depth. One important result shown in this figure is that 530 races (inner and outer) have only Magnetic Perturbation Radial signals which indicate only superficial surface damage or minor corrosion. The visual inspections of these races confirm these results. These races could have been refurbished by a light honing process or polishing. Out of the 1500 races inspected, an additional 811 had no detectable flaws for a total of 1341 races leaving only 159 races with flaws that may be removed by regrinding. Of this group of 159 races, 82 have only magnetic perturbation circumferential signals. This is significant because any flaw detected by the circumferential inspection but not detected by the radial inspection is subsurface. Regrinding may not remove such flaws and may only expose the flaw to the surface making the race more likely to fail. This leaves only 77 races which would most likely benefit from regrinding.

After completion of the before regrind inspections each bearing was reassembled,

INSPECTION RESULTS
INNER RACE MAGNETIC PERTURBATION

```
BEARING PARAMETERS?
00 S04911A 0521 052 0 2 0 1 0 M
TYPE IN TAPE REEL,START?

ENCODER READING AT BEARING REF.
MARK DETECTION  2946
BEARING REF. MARK FROM SHAFT
 ZERO 0003

FLAWS
 TY      ST    BR    SR
CH001   0000 3489 3492 <-- A
CH002   0001 3488 3491 <-- A
CH003   0002 3489 3492 <-- A
CH004   0002 1585 1588 <-- B
RH005   0002 3503 3506 <-- A
CH006   0003 3489 3492
CH007   0004 2069 2072 <-- C
TYPE IN TAPE STOP?
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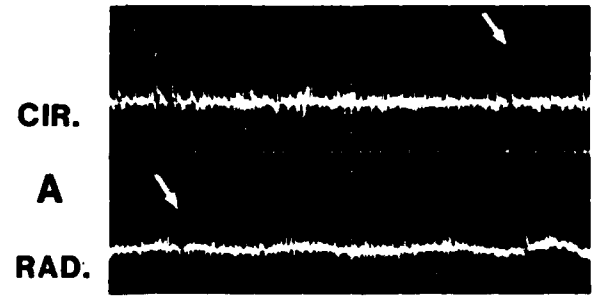

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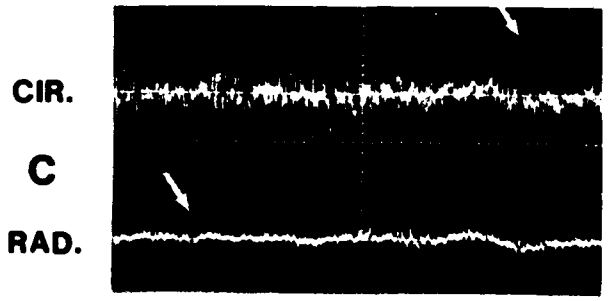
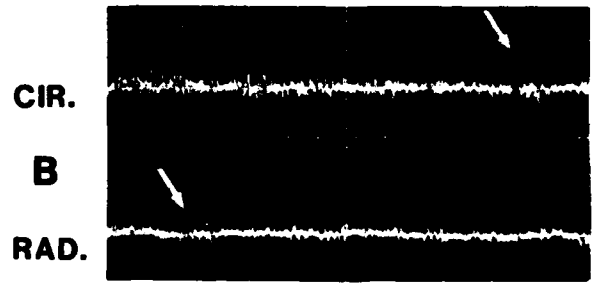




PHOTOMICROGRAPH 50X
(NO SOURCE VISIBLE)

Figure 6: Magnetic Perturbation Inspection Results for Inner Race (S04911A)

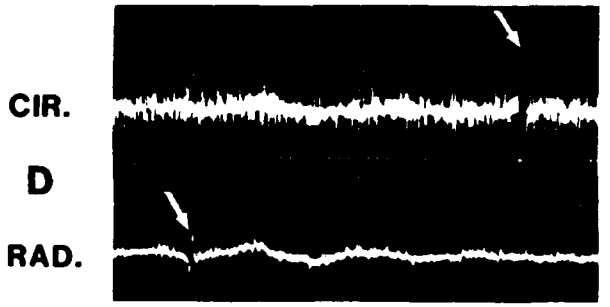
INSPECTION RESULTS
INNER RACE MAGNETIC PERTUBATION

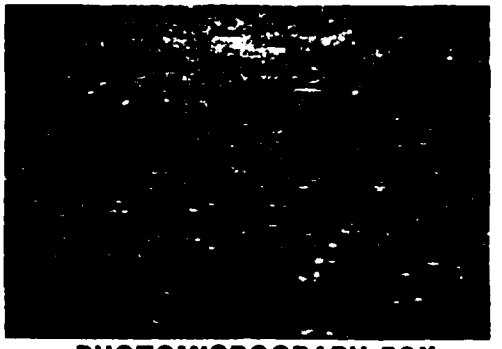
```
BEARING PARAMETERS?
00 S06371A 0870 052 0 2 0 0 0 M
TYPE IN TAPE REEL,START?

ENCODER READING AT BEARING REF.
MARK DETECTION  2947
BEARING REF. MARK FROM SHAFT
 ZERO 0004

FLAWS
 TY      ST    BR    SR
CH001   0000 2629 2633
RH002   0001 4099 4103
CH003   0001 4992 4996
CH004   0001 2629 2633
RL005   0001 4101 4105
TYPE IN TAPE STOP?
```

D
E
F





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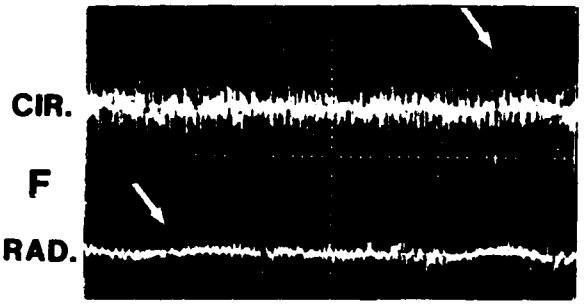

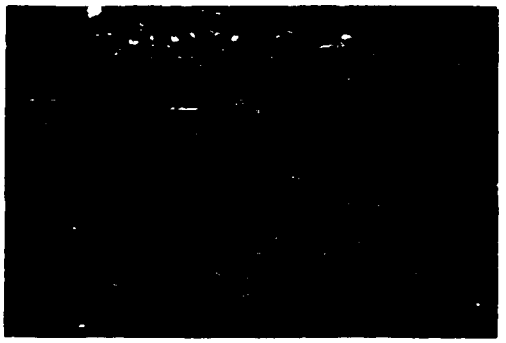

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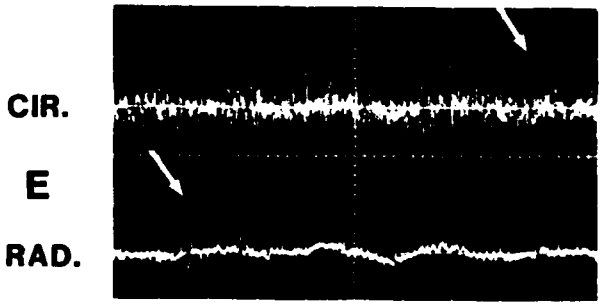

PHOTOMICROGRAPH 50X
(CORROSION PITS)

Figure 7: Magnetic Perturbation Inspection Results for Inner Race (S06371A)

BARKHAUSEN INSPECTION
BEARING SO7501A

NOTE: ARROW INDICATES CHANGE IN SIGNAL

```
BEARING PARAMETERS?
00 S07501A 9999 052 0 0 0 1 0 B
TYPE IN TAPE REEL,START? 0

ENCODER READING AT BEARING REF.
MARK DETECTION  2941
BEARING REF. MARK FROM SHAFT
 ZERO 4998

FLAWS
 TY      ST   BR   SR
BR001  0000 4994 4992
BR002  0001 4993 4991
BR003  0000 1663 1661
BR004  0001 1661 1659
BR005  0000 3330 3328
BR006  0001 3329 3327
TYPE IN TAPE STOP? 0
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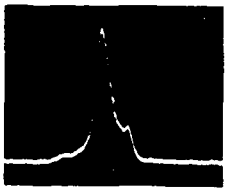
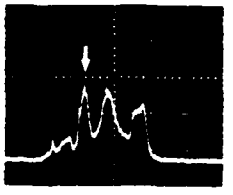
TYPICAL NORMAL SIGNAL INNER RACE



SO7501A INNER RACE #1



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BEARING PARAMETERS?
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TYPE IN TAPE REEL,START? 0

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MARK DETECTION  2930
BEARING REF. MARK FROM SHAFT
 ZERO 4987

FLAWS
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BR002  0001 4992 4979
BR003  0002 4992 4979
BR004  0000 1662 1649
BR005  0001 1659 1646
BR006  0002 1658 1645
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BR008  0001 3324 3311
BR009  0002 3322 3309
TYPE IN TAPE STOP? 0
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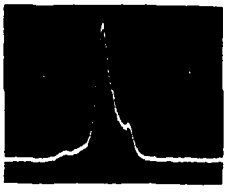
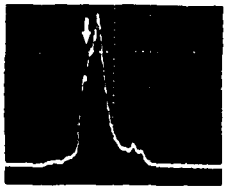


SO7501A INNER RACE #2



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ENCODER READING AT BEARING REF.
MARK DETECTION  2912
BEARING REF. MARK FROM SHAFT
 ZERO 4994

FLAWS
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BR018  0002 4990 4984
BR019  0003 4990 4984
BR020  0004 4989 4983
BR021  0000 1662 1656
BR022  0003 1659 1653
BR023  0004 1659 1653
BR024  0000 3329 3323
BR025  0002 3328 3322
BR026  0003 3328 3322
BR027  0004 3328 3322
TYPE IN TAPE STOP?
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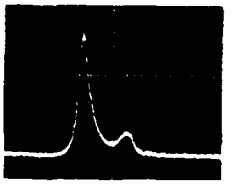
TYPICAL NORMAL SIGNAL OUTER RACE



SO7501A OUTER RACE

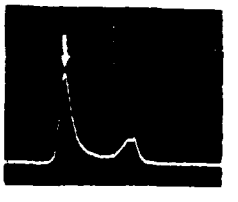
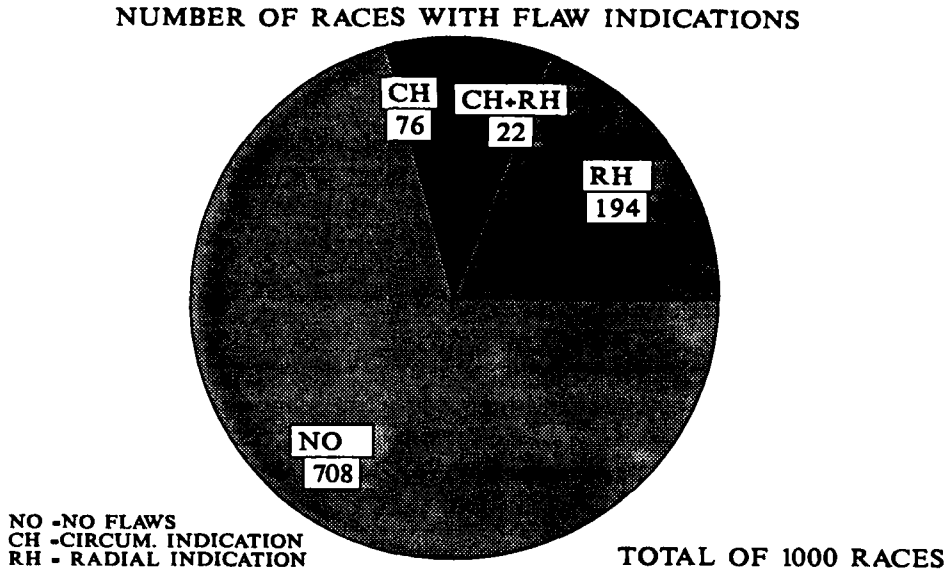


Figure 8: Barkhausen Signal Analysis Results for Bearing (S07501A)

USED INNER RACES



USED OUTER RACES

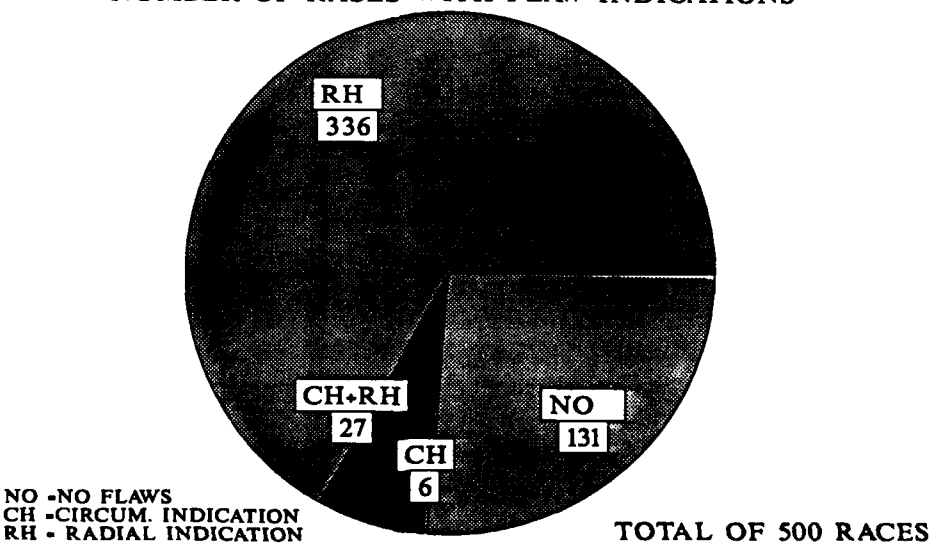


Figure 9: Pie Charts Showing the Number of Races with Magnetic Perturbation Flaw Indications

reoiled and packaged for shipment to ITI for regrind and new balls. The results of the inspections were entered in the bearing database. A file with results for each race was prepared which contains the automatic inspection results, photographs of flaw signals and microphotographs of the surface at each flaw location. The bearings were shipped to ITI in several groups with Fafnir bearings first and New Departure later. The last of the races were shipped to ITI for regrind on April 2, 1982.

B Bearing Race Inspection After Regrind

The project plan called for ITI to refurbish the rejected bearings which had been inspected by SwRI by regrinding the races of all 500 bearings and refitting each bearing assembly with a new set of balls. The original schedule called for this process to be completed in six months. ITI had many difficulties with the regrinding and overall refurbishing process of these bearings. The first shipment of refurbished bearings contained 50 assemblies and was received on December 10, 1982. SwRI inspected these assemblies and found them to be unacceptable due to improper grinding (these results are described later in this section). The total group of 50 bearings were returned to ITI for additional rework. The first group of properly reground bearings were received at SwRI on March 10, 1983. Table 3 is a list showing the date, quantity received, and comments for each group of bearings which were received at SwRI. ITI was able to refurbish a total of 444 bearings. With each refurbished bearing set, ITI furnished SwRI with dimensional information for both the inner and outer races. This information included the race diameter as received, the race diameter after regrind, the amound of material removed from the outer race, the amount of material removed from the inner race and the diameter of the new balls used in the assembly. Appendix D is a complete listing from the dimensional database of this information for each of the 444 bearing assemblies.

The refurbished bearing assemblies were not matched sets of the original races, but were made up of sets of reground inner and outer races which were selected on dimensional criteria to be new mates. Each of these new assemblies were given a new serial number by ITI which was the same as the original outer race serial number with a R added to the front (Example R318AG). This rematching of components was confusing since the inner races no longer had the same serial number as when it was inspected the first time at SwRI. The confusion over the serial numbers of the refurbished bearings became even worse when ITI destroyed 200 of the original outer races. These outer races were damaged beyond repair when the regrinding process produced severe grinding burns in a large percentage of these races. ITI manufactured new outer races to replace the damaged races. Since these new races had no serial numbers, ITI assigned the bearing assemblies with these new outer races a serial number of the original inner race with a R added to the front (Example R318AG). This process produced a large number of duplicate serial numbers. To avoid confusion, this report will utilize the number assigned by SwRI to identify the bearing components. A cross-reference of numbers is included in Appendix E.

Date Received	Quantity	Comments
12-10-82	50 Each	Returned*
03-10-83	12 Each	Reworked
03-18-83	13 Each	Reworked
03-21-83	38 Each	Reworked
04-12-83	31 Each	Reworked
05-23-83	39 Each	Reworked
06-21-83	23 Each	Reworked
08-01-83	82 Each	Reworked
10-17-83	9 Each	Reworked
03-26-84	115 Each	New Outer Race
03-28-84	25 Each	New Outer Race
04-18-84	39 Each	New Outer Race
05-17-84	18 Each	New Outer Race

*50 bearings were returned to ITI on 1-27-83 because of excess "waviness".

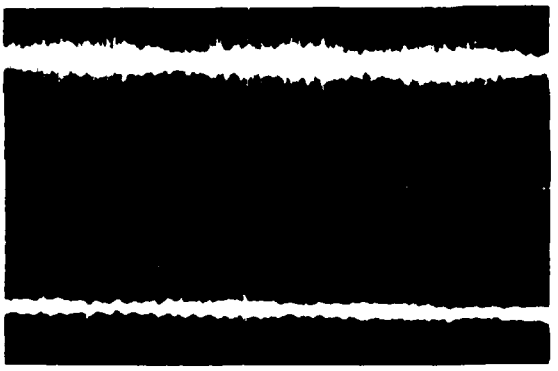
Table 3: Shipments of Refurbished Bearings from ITI

The first 50 bearings received at SwRI to be inspected after being refurbished were found to be unacceptable as mentioned in the previous paragraph. These bearings were received at SwRI disassembled and cleaned. The inner races were inspected first and the inspections produced no unexpected or unusual results. After completion of the inner race inspections, the outer race inspections produced unexpected difficulties. A high amplitude sinusoidal magnetic perturbation signal was generated from the races during the radial mode inspection. A comprehensive check of the setup and equpment was performed and since the reference bearing generated no sinusoidal signal, it was concluded that the source of the signals was most likely a waviness in the surface of the ball groove of the reground races. To confirm this assumption, it was decided that the races should be checked for runout on a precison measuring system which was designed to detect deviations of profile. SwRI does not have the capability of making this measurement but personnel at CCAD were contacted and it was determined that the required measurements could be made at the CCAD Metrology Laboratory. After confirming the availability of the required equipment, a representative of SwRI was dispatched to CCAD with three reground bearings and a reference bearing to be measured. The equipment utilized to make the measurements was a Talyrond Model II. The results of this exercise are shown in Figures 10 and 11.

Figure 10 is the results for the reference bearing which was not reground. The photograph at the top of the figure shows the circumferential high field magnetic perturbation signature and the magnetic perturbation radial high field signature which look normal. The Talyrond trace shows a graph of the deviation from a perfect circle for the outer bearing race as measured at three locations across the ball groove. These results are typical of a good bearing.

Figure 11 shows the results of a reground bearing which was received in the first 50 bearings. The photograph at the top of the figure shows the circumferential high field signature and the radial high field signature as recorded during the initial inspection of the reground bearing. Note the high level sinusoidal signal which has a frequency of 38 cycles per revolution. The Talyrond trace in the middle of the figure shows a corresponding sinusoidal signal with a maximum amplitude of .00014 inches. This is an unacceptable amount of waviness for a high speed engine bearing. All 50 of the bearing assemblies were returned to ITI for additional rework. The photograph at the bottom of Figure 11 shows the circumferential high field signature and the radial high field signature after the bearing had been honed at ITI to remove the waviness.

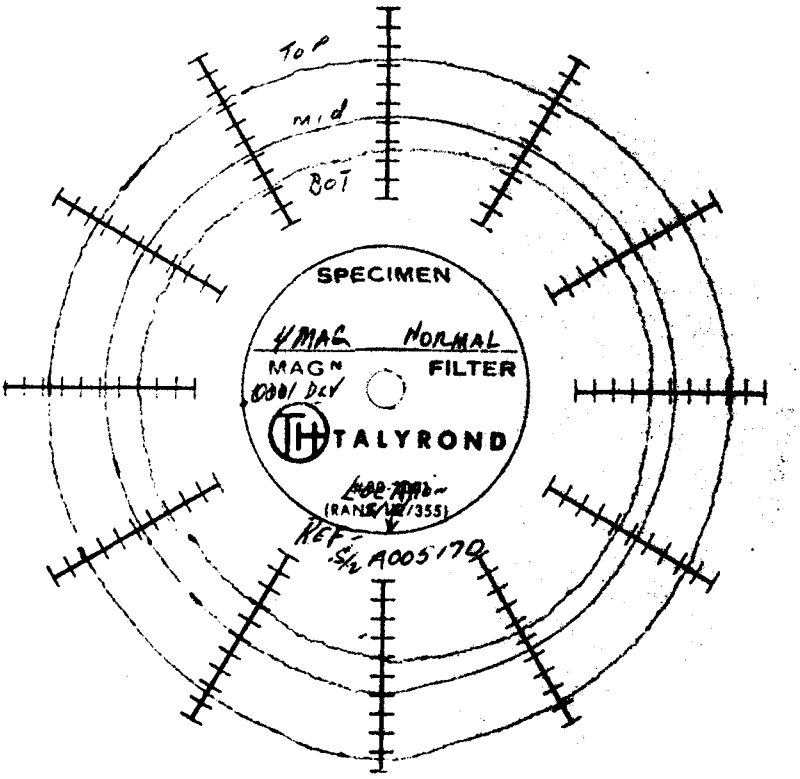
Figure 12 is a pie chart showing the distribution of reground bearings as finally received from ITI. This chart accounts for all 500 of the original bearings. The 56 bearing assemblies which were not refurbished by ITI were bearings which were missing the ball cages when received at SwRI from CCAD. ITI could not produce refurbished



Circumferential High Field

CIBLE INSPECTION RESULTS
OUTER BEARING RACE USED
(REFERENCE) S/N A005170

Radial High Field



TALYROND TRACE

Sensitivity 0.0001 in./div.

Figure 10: Talyrond Results For The Reference Bearing Which Was Not Reground

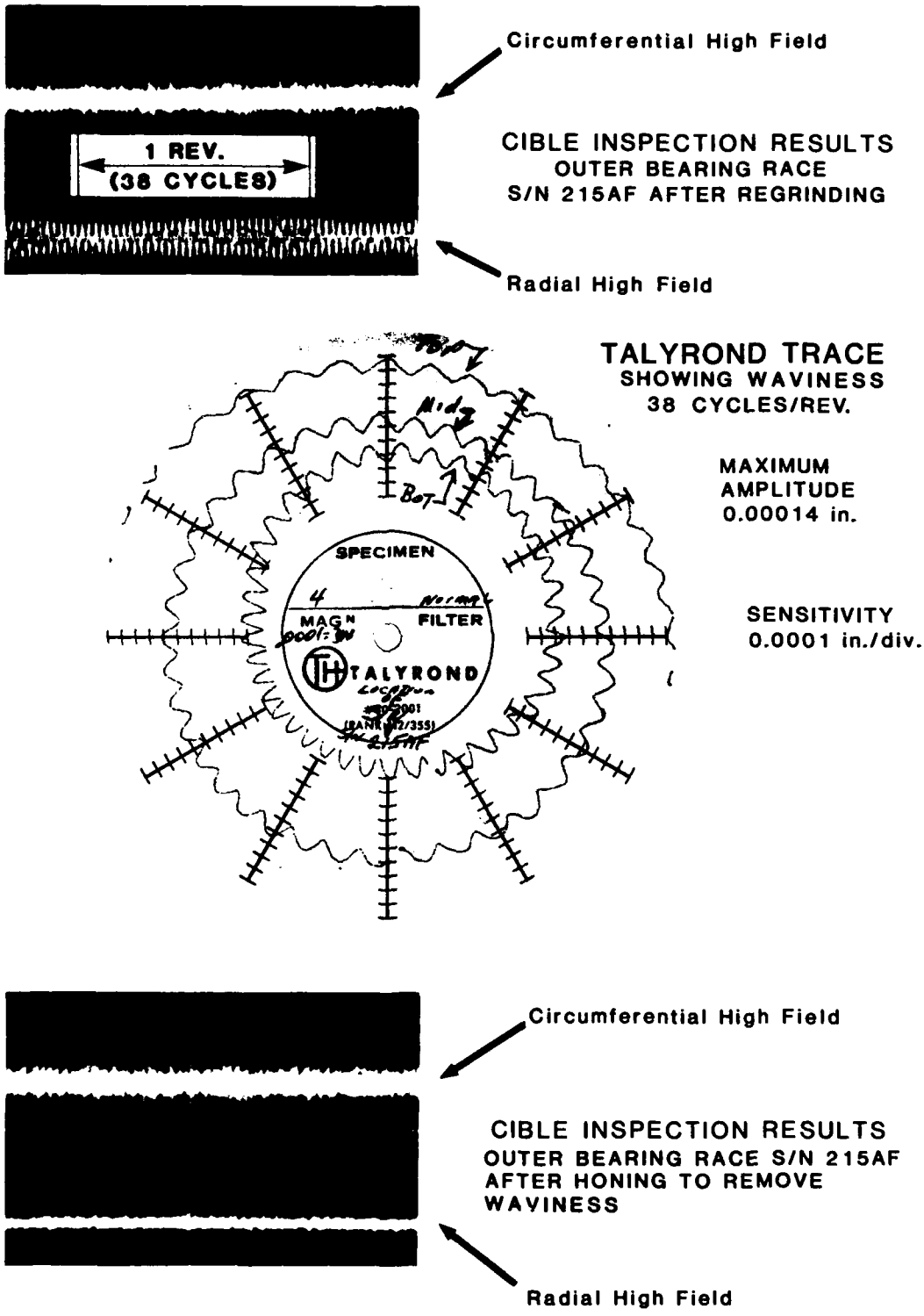
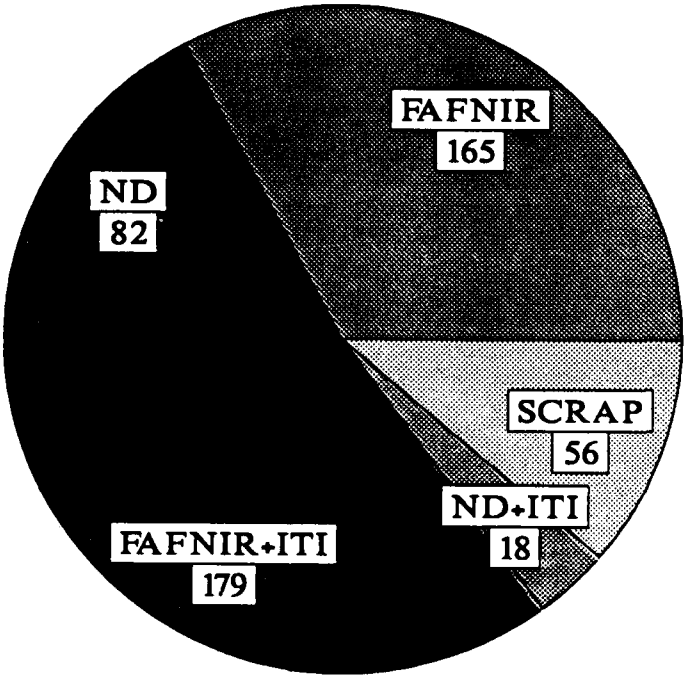


Figure 11: Talyrond Results Of A Reground Bearing Which Was Received In The First 50 Bearings

REFURBISHED BEARINGS

P/N 1-300-015 -02/04

TOTAL 500 USED BEARINGS



ITI = INDUSTRIAL TECTONICS INC.

ND = NEW DEPARTURE HYATT

Figure 12: Bearings Refurbished by ITI

bearings without the ball cages. The pie sections labeled ND + ITI and FAFNIR + ITI are assemblies which have a new outer race fabricated by ITI to replace a race destroyed by improper grinding.

The results of the inspection of these 444 bearings after refurbishing produced some interesting results. These results are shown in the pie charts in Figure 13. By doing a comparison of the number of flaws detected by each type of inspection utilized in the CIBLE system, the following observations can be made:

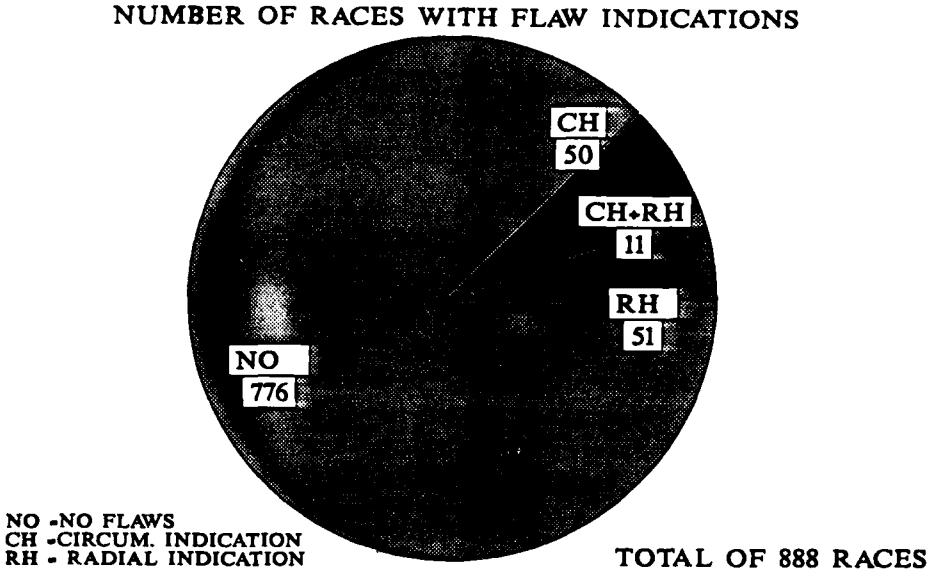
1. Comparing the number of races which had only CH signals before and after regrind shows little change or improvement in the number of races. This result is not surprising since CH signals which are detected without an accompanying RH signal indicate that the source of the signature is subsurface. In this case, regrinding the race may not remove the source of the signal and may indeed expose a subsurface flaw to the new surface. Certainly for this type of flaw the wisdom of regrinding these races is questionable. Figure 14 shows an example of a flaw which was detected prior to regrind and was also detected after regrind. In this example, the flaw is subsurface and was not exposed by regrinding but the amplitude of the circumferential is larger after regrinding indicating the flaw is nearer the surface. Thirty other races have been identified in which CH flaw indications still exist after regrind.

2. Making a comparison of races which had CH + RH signals before and after regrind shows a significant decrease in the number of races in this category. Both CH and RH signals from the same location indicate a flaw of significant size and is at the surface or near surface. This type of flaw is usually a scratch, inclusion, or corrosion. These results show that regrinding reduced the number of races with this type of flaw significantly but inspection after regrind should be performed to insure the flaws have been entirely removed.

3. A comparison of bearings which had only RH signals before and after regrind shows a very large decrease in the number of races in this category. A RH signal without an accompanying CH signal at the same location indicates a surface flaw which is superficial mechanical damage or very minor corrosion. This type of damage can most likely be removed without grinding by honing or polishing the surface.

4. Figure 15 is a pie chart showing the number of races with magnetic perturbation indications from the 197 new outer races manufactured by ITI. Comparing these results to the results for reground outer races in Figure 13 shows a much large number of the new outer races have CH signals which would indicate subsurface flaws. The percentage of races with CH flaws is unusually high at 59%. This is likely the result of poor quality material.

REGROUND INNER RACES



REGROUND OUTER RACES

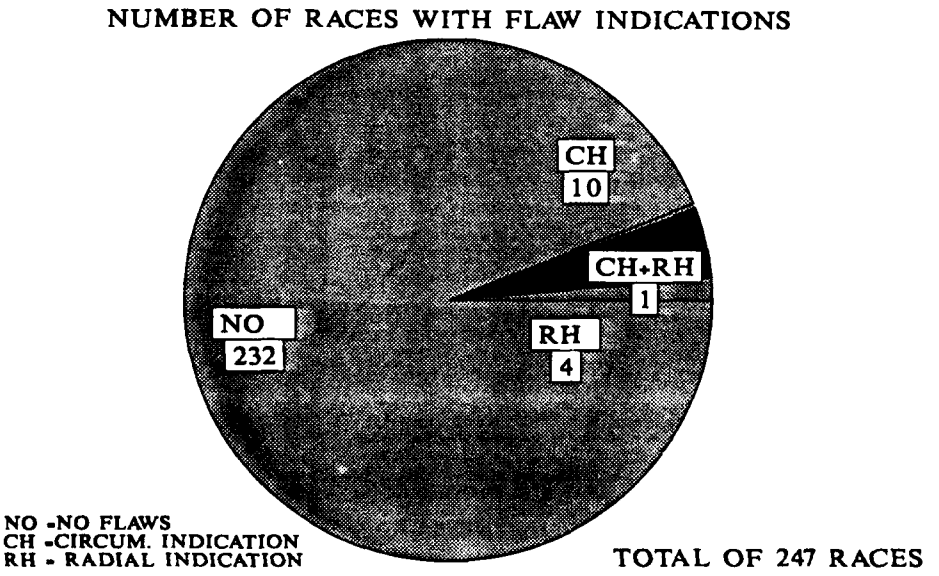


Figure 13: Pie Chart Showing The Number Of Races With Magnetic Perturbation Flaw Indications After Regrind

INSPECTION RESULTS
INNER RACE S/N 18250(SO2771)

BEFORE REGRINDING

AFTER REGRINDING
(0.0016 in. REMOVED)

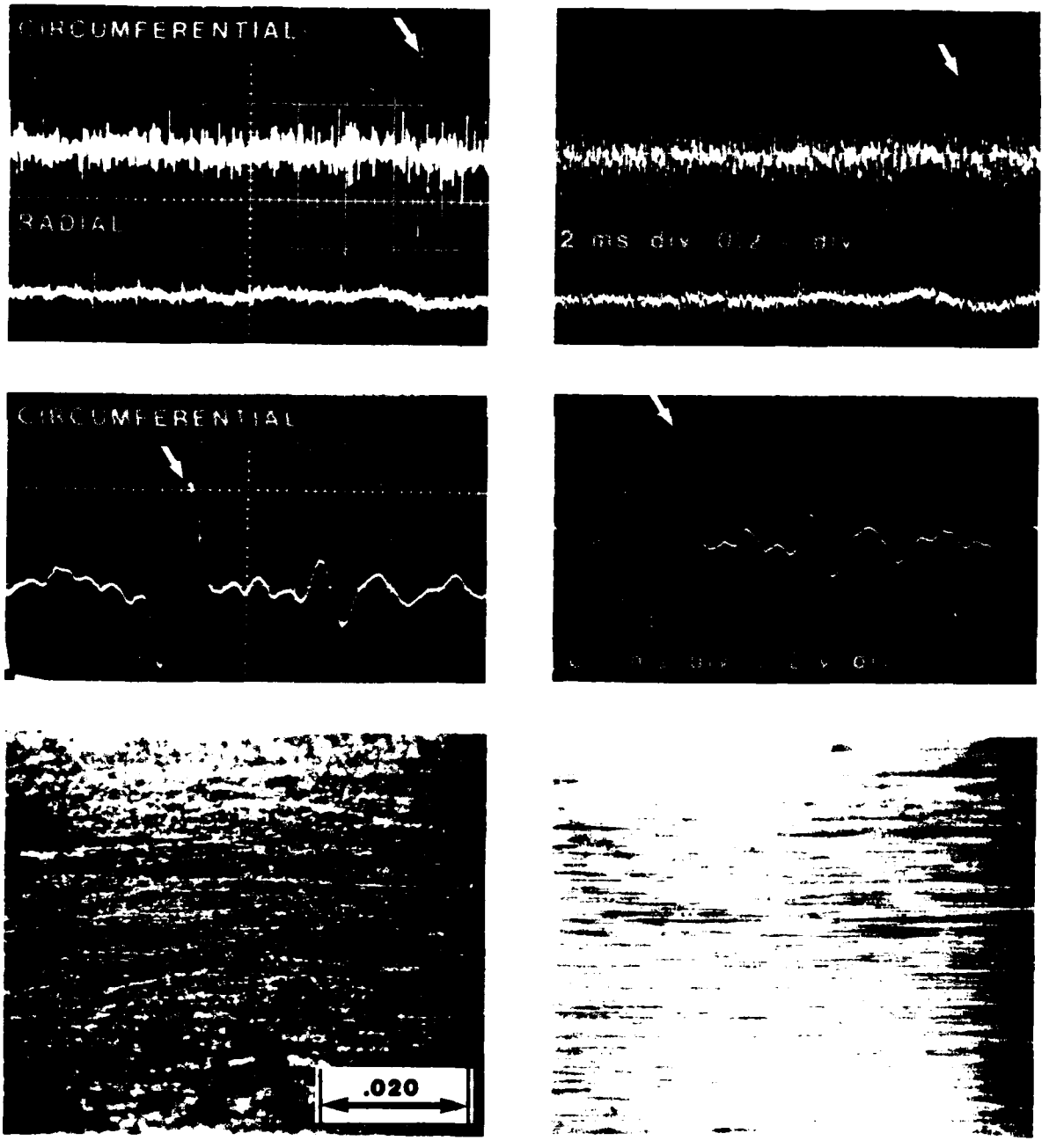


Figure 14: Magnetic Perturbation Inspection Results for Inner Race (S02771)

ITI MANUFACTURED OUTER RACES

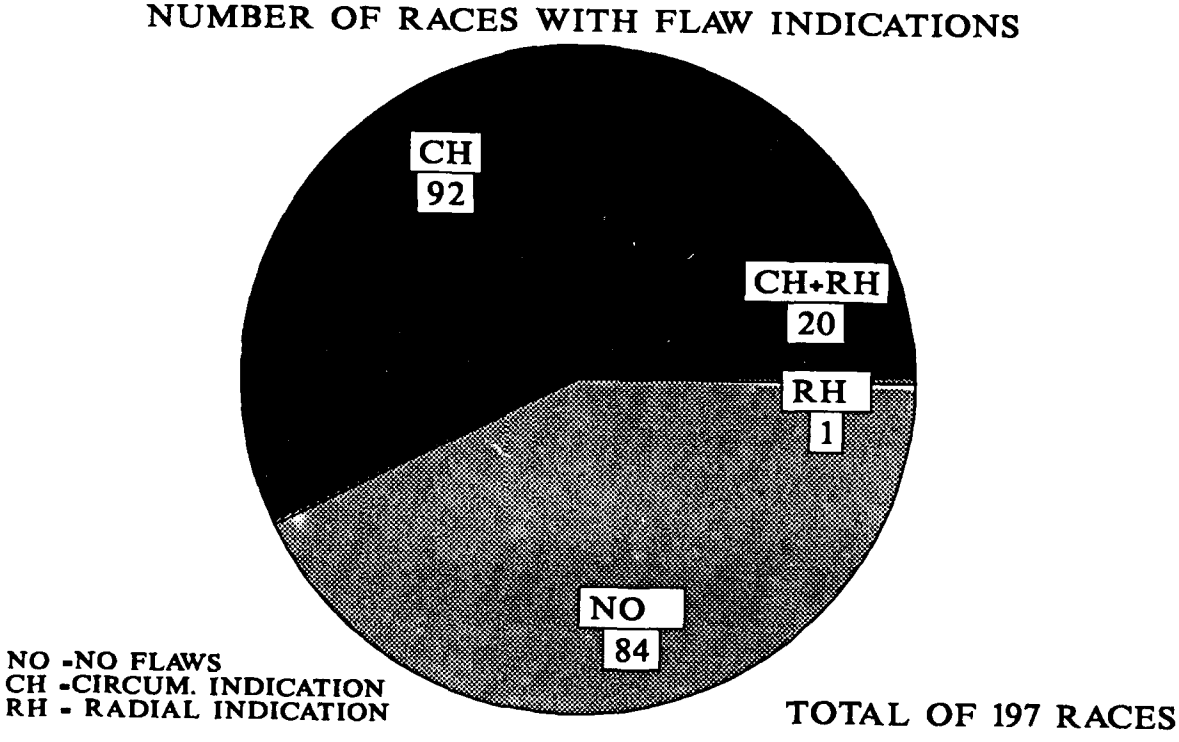


Figure 15: Pie Chart Showing the Number of New Outer Races Manufactured by ITI with Magnetic Perturbation Flaw Indications

5. Comparing the results of the Barkhausen stress indicator is difficult in that only a small percentage of the original races showed indications of abnormal stresses. A comparison of the results before and after regrind indicates that the number of races with non-uniform stresses was reduced significantly from 28 races to 4 races. One bearing, SwRI I.D. S07501, had abnormal Barkhausen signatures before regrinding as shown in Figure 8. This bearing also produced abnormal Barkhausen signals after regrinding. Since all three races (2 inner halves and 1 outer) produced abnormal responses, the most likely cause for these changes in residual stress is overheating. Hardness testing revealed all three races of this bearing had hardness of less than R_c50 as compared to the specified hardness of R_c60 to R_c62. This overall softening of the steel could not be corrected by regrinding. This bearing was included in endurance test No. 17 and failed early at 73.4 hours.

C Selection of Bearings for Endurance Testing

Representatives of TSARCOM and SwRI developed an endurance testing plan which required testing both reground and new bearings. The endurance test plan called for testing ten new bearings and 28 reground bearings.

CCAD furnished SwRI with ten sets of new Fafnir 1-300-015-004 bearings for the endurance testing. Each of these bearings were disassembled and inspected using the CIBLE equipment to insure that these new bearings were representative of a flaw-free new bearing. The results of these inspections are shown in Table 4.

The 28 reground bearings were selected to include sample bearings representative of each of the flaw types which were detected during the CIBLE inspection. This group included bearings with magnetic perturbation circumferential and radial flaw indications, bearings with abnormal Barkhausen signals, and bearings in which no flaws were detected. The bearings selected needed to have the flaw condition isolated to the load track of either the inner or outer race of the selected bearing. A team of engineers representing SwRI and TSARCOM performed the actual selection. Appendix C, the Army Bearing Endurance Test Reports, document the "Reason Selected" and "Endurance Test Results" for each bearing.

CIBLE

INSPECTION RESULTS

FOR 10 NEW BEARINGS

SwRI No.	Army S/N	Number of Indications
S07671	445BA	1 CH Outer Race
S07701	712 BC	0
S07711	J0682	0
S07721	J0683	0
S07731	J0696	0
S07741	J0698	2 CH Inner Race
S07751	J0705	1 CH Inner Race
S07761	J0711	0
S07771	J0718	0
S07781	J0729	0

Table 4: CIBLE Inspection Results For 10 New Bearings

IV ENDURANCE TESTING

A High Speed Thrust Bearing Endurance Tester

A bearing endurance tester consisting of a drive system connected to two test-bearing heads, designed and fabricated specifically for use on this program, was provided by Southwest Research Institute (SwRI). Each test bearing head was equipped with its respective instrumentation and test-oil lubrication system. A thrust bearing test machine employed earlier on a TSCARCOM sponsored program [1] at SwRI was capable of a maximum rotational speed of approximately 16,000 rpm. Since it was desirable to rotate the inner race (ring) of the test bearings at 24,000 rpm for this program, a redesign and development of the drive system for the current tester was required. The recently designed high-speed thrust bearing endurance tester has been successfully operated for a total of approximately 2,200 hours at 24,000 rpm with minimal maintenance and upkeep. Details of the drive system, test-bearing heads, test-oil systems, and instrumentation are presented in the following paragraphs:

1. Drive System

   The drive system for the tester was powered by a 50-hp electric motor through a variable-speed, water-cooled, Dynamatic drive which drives a two-stage, flat-belt speed increaser to obtain the desired speed. The intermediate-speed shaft and high-speed shaft were both simply-supported in tandem-mounted, oil mist lubricated ball bearings. Each end of the high-speed shaft was connected to a test bearing head through a flexible coupling. The tester had the capability of operation with two test heads attached (one on each end) or with only one test head attached. Therefore, if bearing failure was experienced in one head during testing, it could simply be detached from the shaft and testing could continue using the other head. A photograph of the assembled tester showing drive system, test bearing heads, and test-oil lubrication system is presented in Figure 16

2. Test Bearing Heads

   The endurance tests were performed employing test-bearing heads (two each), especially modified to accept supplied 50-mm bore, angular-contact, ball bearings. As shown in Figure 17, two test bearings (19), in each test-bearing head, were loaded one against the other by means of pneumatic pressure applied to a flexible diaphragm (8) which was transmitted to the load plate (6). The load plate, in turn, transmitted the load to the outer race of the front bearing, through the bearing balls of the front bearing to the rear inner race of the front bearing, through the spacer (16) to the front inner race of the rear bearing, through the balls of the rear bearing to the outer race of the rear bearing. The retainer (11) was used for securing the test bearing component. The thrust load applied to the test bearings was transmitted to the support (4), through studs (7), and back to the front cover (14). The rear end (flexible- coupling end) of the main shaft (1) was

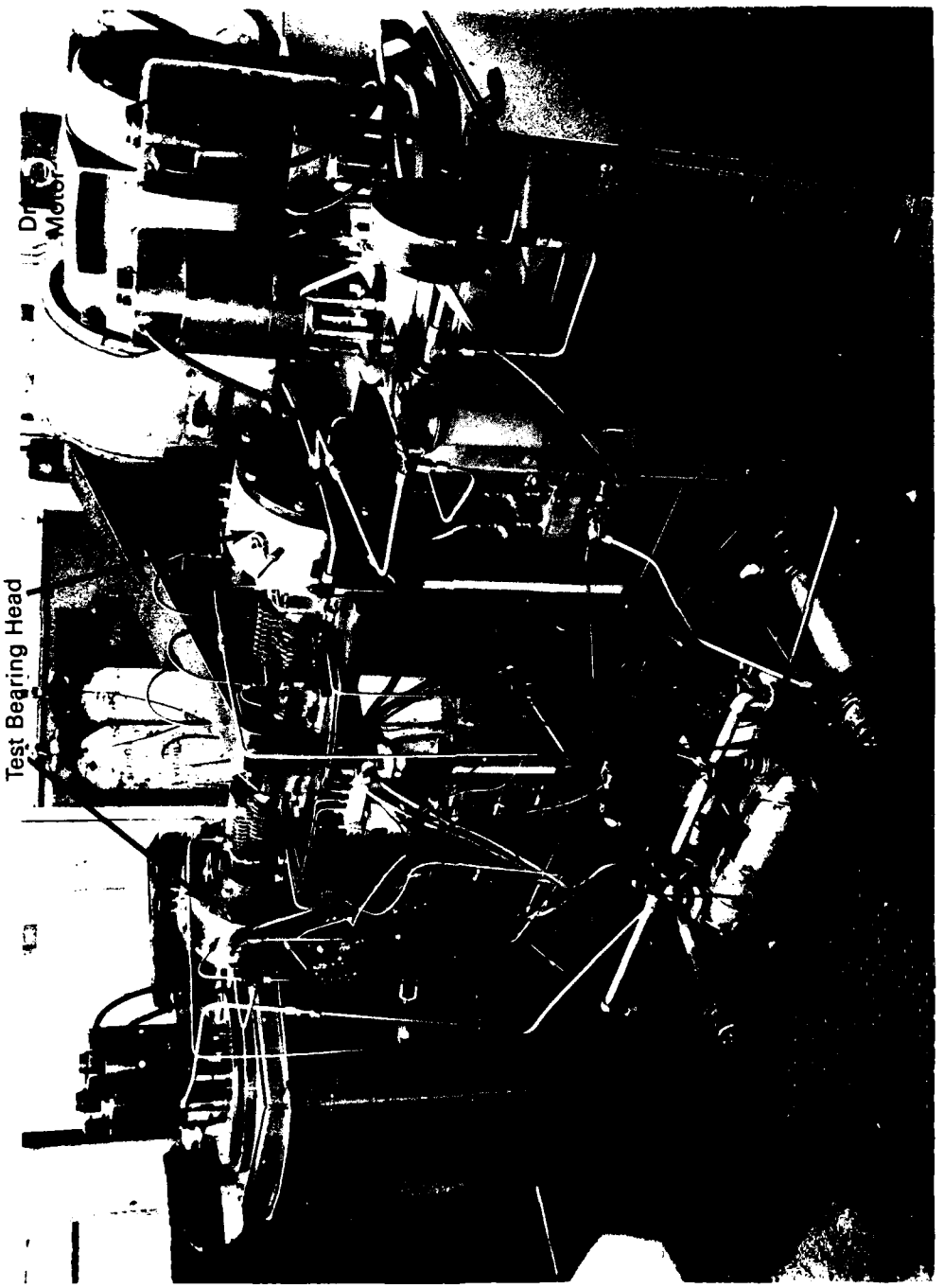


Figure 16: High-Speed Thrust Bearing Endurance Tester

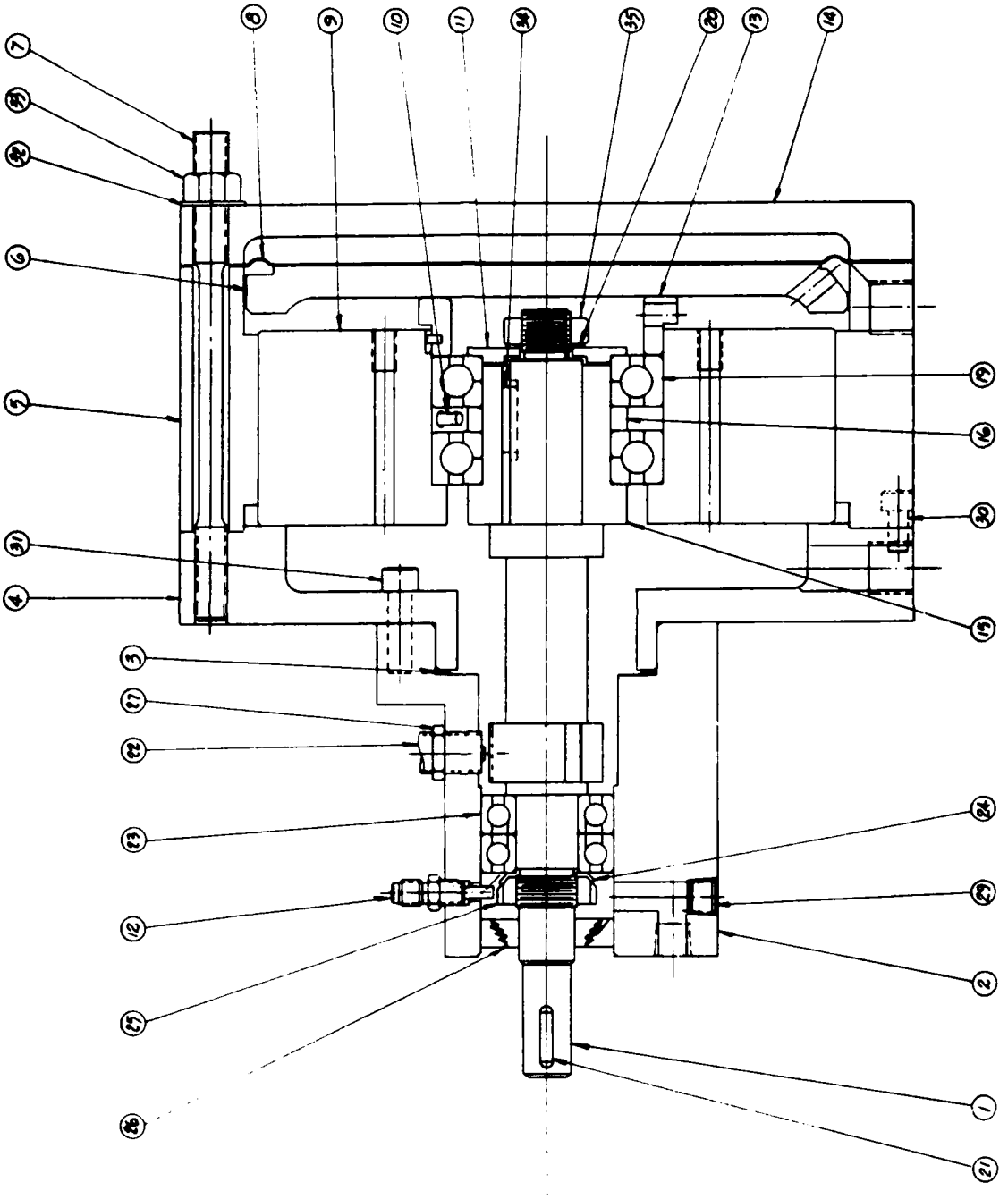


Figure 17: Cross-Section Of SwRI Test-Bearing Head

supported by duplex ball bearings (23). These bearings were lubricated with three oil jets (12) located at 120° spacing around the housing (2). Test oil was employed for lubricating these bearings, as opposed to another lubricant source, to prevent contamination of the test-oil system. A high-speed gap seal (26) prevented oil leakage from the rear of the tester. A magnetic sensor (22), triggered by slots in the main shaft, was used to determine rotating speed during testing.Test oil was supplied to the two test bearings by four tubes (10) located between the bearings and spaced at approximately 90° around the main housing (5). Each tube had two 0.040 inch jets, one directed at each test bearing. All test oil supplied by the eight jets (approximately 5,500 ml/min.) passed through the two test bearings. The oil exited the test-bearing head through two scavenge ports, one located in front of the test bearings and one behind, and also one scavenge port located at the rear of the head behind the duplex support bearings. Each test-bearing head was instrumented with an accelerometer which was preset to the desired amplitude of vibration for bearing tester "shutdown from bearing failure." Thermocouples provided temperatures of outer bearing races during testing.

3. Test-Oil Systems

The test-oil systems employed with each of the test-bearing heads were similar and resembled those used for the 48-hour bearing deposition tests required in qualification of MIL-L-7808 lubricants[2]. One major difference from the 48-hour bearing deposition testers were 3-μm stainless-steel, recleanable filters, installed immediately upstream from the test-oil jets. The 3-μm filters were used for all bearing tests performed in this program. This assured clean test oil to the test bearings. The test-oil pressure pump and scavenge pump were both driven by 1/3 hp variable-speed motors, through direct drive couplings. The variable speed capability permitted controlling constant oil flow rate to the bearings in the event of partial filter "plugging" and/or pressure pump wear during testing. Test oil was supplied to the oil jets at 45$\pm$ 5 psig pressure. The test oil was scavenged from the test-bearing heads through scavenge lines to a test-oil cooler and returned to the test-oil sump. Pressure gauges upstream and downstream from the test-oil filter provided pressure drop through the filter during testing. Also, the pressure gauge downstream from the filter provided the oil pressure to the test-oil jets. Sump heaters provided heat to the test-oil as needed to control the oil temperature at the desired level. Thermocouples in each sump provided millivolt outputs for both recording and controlling test-oil sump temperatures.

4. Instrumentation

The high-speed thrust-bearing endurance tester was designed to operate continuously without operator assistance or attendance. The tester had safety features as follows:

- High test-bearing temperature

- High test-oil temperature
- High and low test-bearing rpm
- High and low test-oil pressure
- Low-level of support bearing misting lubricant

Any one or a combination of these parameters would stop operation of the tester. Simultaneously, an indicting light would show which parameter caused shutdown. Also, an electrical power failure would cause shutdown, and the tester would not restart without operator assistance. The following paragraphs provide additional pertinent information about the tester instrumentation.

A multipoint, strip-chart temperature recorder was employed to provide a permanent record of temperatures of interest during testing. Some of the temperatures monitored were test oil in the sumps, test-oil in (to each test bearing head), test-oil out (in the scavenge lines from each test bearing head), front test-bearing outer race (both heads), rear test-bearing outer race (both heads), and the outer races of both support bearings in each bearing head. The test-oil sump temperatures were controlled with a test-oil coolers (heat exchanger) and controller and test-oil sump heaters and controllers Test-bearing temperatures were controlled by controlling the temperatures of the jetted-oil to the bearings.

Each test-bearing head was instrumented with a variable-trigger network that received a signal from an accelerometer and automatically shut the tester down at a preset vibration level. Spalls or pits that propagated in any of the test bearings would actuate the automatic shutdown. Size of the spall generated was dependent upon the amplitude of preset vibration level above the normal background vibration level.

Test bearing rotational speeds were monitored by an rpm indicator that also had an over-and under-speed safety control for tester shutdown in the event of speeds outside the preset range. This rpm indicator received its signal from the magnetic sensor located in the test-bearing head.

B Summary of Endurance Testing

A total of nineteen high-speed endurance tests, employing thirty-eight test bearings, were performed using the tester previously described. The specified test conditions were as follows:

- Speed - 24,000 rpm
- Test bearing lubricant - MIL-L-23699C specification (specifically Mobile Jet Oil II)
- Sump oil temperature - controlled at 200°F (93°C)

- Number and size of lubricant jet for each test bearing - 4 each spaced at 90° around bearing, each jet having 0.040-inch diameter
- Test lubricant pressure at jets -40 to 45 psig
- Test lubricant flowrate through each test bearing - 2,750 ml/min. (43.6 gal/hr)
- Test bearing thrust load - 3,914 lbs

Initially it was decided that all of the bearings for high-speed endurance testing would be of a single manufacturer and configuration. These would be Fafnir design having 14 each 0.500-inch diameter balls with 27°-30° angular contact. The calculated maximum Hertz stress for these bearings having a measured thrust load of 3,914 lbs was 350,000 psi at the inner-race contacts. Inadvertently, three of the tests were performed with bearings of New Departure design containing only 13 each 0.500-inch diameter balls and having 19°-25° angular contact. Needless to say, since these three tests were performed at the same thrust loads, the resulting maximum Hertz stress was significantly higher, having a calculated value of approximately 392,000 psi. All of the endurance tests performed are briefly summarized in Table 5. Shown in the table are the total number of hours and total number of revolutions each bearing (two bearings per test) was endurance tested. Once a test was halted, either because of a "vibration shutdown" or some other reason, and the bearings were removed from the test bearing head, the test was considered complete and no further endurance testing of those particular bearings was performed. Because of this, Table 5 shows three tests (Test No. 1, 3, and 12) where no bearing failures were observed and these were considered censored bearings. These censored bearings or samples will be discussed later in the statistical analysis section of the report. Also shown in the table are the three tests (Test No. 5, 6, and 7) inadvertently performed with New Departure bearings, which had one less ball, resulting in a significantly higher Hertz stress. For the endurance test analysis, these three tests were deleted from the study instead of using a Hertz stress-endurance life relationship to estimate what the failure life would have been at the lower stress level of 350,000 psi. Also, the different configuration of these bearings, such as contact angle, number of test balls, etc., suggest that the bearings should not be grouped together with the remaining tested bearings for statistical study purposes. One other test (Test No. 16) was eliminated from the statistical study because of inferior bearings. The bearings in this test were found to be extremely rough and gave very large vibration levels at the initiation of testing. Consequently the test only lasted 10.8 hours and was not considered of value for statistical evaluation of endurance testing. The remainder of the 15 endurance tests, employing 30 test bearings (ten new bearings and 20 reworked bearings) appeared to produce excellent results for statistical evaluation.

Extreme care was taken in assemblying the test bearings and installing the test lubricant, as well as during testing, to maintain cleanliness in order to minimize the introduction of invalid testing results through debris-indentation initiated spalls. In

Test No.	Test Bearings Mfgr.	New or Reworked Bearings	Max. Hertz Stress, Ksi	No. Test Hours	Test Revolutions $X10^{-6}$	Visual Bearing Failure Mode
1	Fafnir	New	350	105.3	151.6	None
2	Fafnir	Reworked	350	123.4	177.7	Spall, inner ring, front bearing
3	Fafnir	New	350	507	730.1	None
4	Fafnir	Reworked	350	411.7	592.8	Spall, inner ring, front bearing
5	New Departure	Reworked	392	24.5	35.3	Spall in ball, rear bearing
6	New Departure	Reworked	392	165.4	238.2	Ball spall, front brg.; spall, inner ring, rear brg.
7	New Departure	Reworked	392	20.5	29.5	Rough brgs., "inferior quality"
8	Fafnir	New	350	245.8	353.9	Spall, outer ring, front brg.
9	Fafnir	New	350	237.3	341.7	Spall, inner ring, rear brg.
10	Fafnir	New	350	219.1	315.5	Spalls, outer ring, front & inner ring, rear*
11	Fafnir	Reworked	350	172.6	248.5	Spall, outer ring, rear brg.
12	Fafnir	Reworked	350	296.1	426.4	None
13	Fafnir	Reworked	350	73.6	106.0	Spall, inner ring, rear brg.
14	Fafnir	Reworked	350	190.6	274.5	Spall in ball, front brg.
15	Fafnir	Reworked	350	282.5	406.8	Spall, inner ring, front brg.
16	Fafnir	Reworked	350	10.8	15.6	Inferior brgs.
17	Fafnir	Reworked	350	73.4	105.7	Spalls, inner ring, front brg.
18	Fafnir	Reworked	350	167.0	240.5	Spall, inner ring, rear brg.
19	Fafnir	Reworked	350	118.1	170.1	Spall, outer ring, front brg.

* Both bearings had visual spall failures at the end of this test.

Table 5: Summary Of Bearing Endurance Tests

Test No.	Brg. No.	Test Hours	Total Test Revolutions $X10^{-6}$	Total Stress Cycles, $X10^{-6}$		Bearing Failure Location
				Inner Ring	Outer Ring	
1	J0682	105.3	151.6	1,230	892	None
1	712BC	105.3	151.6	1,230	892	None
10	445BA	219.1	315.5	2,561	1,856	Outer ring
10	J0729	219.1	315.5	2,561	1,856	Inner ring
9	J0718	237.3	341.7	2,773	2,011	None
9	J0711	237.3	341.7	2,773	2,011	Inner ring
8	J0705	245.8	353.9	2,872	2,082	Outer ring
8	J0698	245.8	353.9	2,872	2,082	None
3	J0696	507.0	730.1	5,926	4,296	None
3	J0683	507.0	730.1	5,926	4,296	None

Table 6: New Bearing Endurance Test Data

addition, 3μm stainless steel recleanable filters were maintained immediately upstream from the test-oil jets supplying lubricant to the test bearings. All of the test lubricant to the test bearings passed through these filters prior to being jetted on or through the bearings. In addition, the use of a highly sensitive vibration monitoring (accelerometer) system assured early detection of bearing failures, which facilitated a more definitive analysis of bearing failures. A procedure for setup and use of this vibration monitary system is presented in Appendix B.

C Results of Endurance Testing

Tables 6 and 7 present the endurance test data for new (not reworked) and reworked bearings, respectively. Shown in the tables are the calculated total stress cycles that each bearing inner ring and outer ring underwent during the endurance testing. For rolling-element contact bearings (ball bearings in this particular study), the expected fatigue failure (spall) may occur in either ring (raceway) or in any of the rolling elements. Since a ball axis of rotation tends to change with each orbit in a ball bearing, ball fatigue failure is much less frequent than raceway fatigue failure. As noted in this study, out of 13 total spall failures (visually observed), 12 were ring raceway failures and only one failure (spall) was located in one of the bearing balls. Each of these bearings had 14

Test No.	Brg. No.	Test Hours	Total Test Revolutions X10^{-6}	Total Stress Cycles, X10^{-6}		Bearing Failure Location
				Inner Ring	Outer Ring	
17	(N)R9638AS	73.4	105.7	858	622	Inner ring
17	R4124	73.4	105.7	858	622	None
13	(N)R966AH	73.6	106.0	860	624	None
13	R159AH	73.6	106.0	860	624	Inner ring
19	R3269AS	118.1	170.1	1,381	1,001	Outer ring
19	R111T	118.1	170.1	1,381	1,001	None
2	R289AN	123.4	177.7	1,442	1,046	Inner ring
2	R965AH	123.4	177.7	1,442	1,046	None
18	R4638	167.0	240.5	1,952	1,415	None
18	(N)R1271	167.0	240.5	1,952	1,415	Inner ring
11	(N)R1731	172.6	248.5	2,017	1,462	None
11	R5411AS	172.6	248.5	2,017	1,462	Outer ring
14	(N)R243AC	190.6	274.5	2,228	1,615	Ball
14	R1084	190.6	274.5	2,228	1,615	None
15	R5599AS	282.5	406.8	3,302	2,394	Inner ring
15	R987AP	282.5	406.8	3,302	2,394	None
12	(N)R543AH	296.1	426.4	3,416	2,509	None
12	R778P	296.1	426.4	3,416	2,509	None
4	R375AF	411.7	592.8	4,811	3,488	Inner ring
4	R343AM	411.7	592.8	4,811	3,488	None

Table 7: Reworked Bearing Endurance Test Data

balls giving a total of 182 rolling elements in the 13 failed bearings.

The total number of inner ring and outer ring stress cycles shown in Tables 6 and 7 were calculated using equations presented in "Rolling Bearing Analysis" by Harris.[3] These equations are as follows:

$$u_i = 0.5Z \quad (1 + \frac{D}{d_m}.\cos\alpha)$$

$$u_o = 0.5Z \quad (1 - \frac{D}{d_m}.\cos\alpha)$$

where u_i and u_o = number of stress cycles per revolution for inner ring and outer ring, respectively

Z = number of rolling elements (balls) per bearing
D = ball diameter
d_m = pitch diameter
α = average bearing contact angle

In ball bearings rotating under load, the raceways and balls are subject to varying stresses and deformations. Bearings adequately lubricated and protected from the entrance of foreign debris, and operating at sufficient stress levels will eventually fail due to fatigue of the bearing material at some stressed location. The fatigue failure ordinarily takes the form of surface spalling. When a group of "near" identical bearings do not fail at the same life, it is necessary to treat the failure data statistically. The

application of the calculus of probability has led to the fundamental law of the Weibull theory [3] as a statistical approach for handling the data for most bearing endurance studies. Therefore, for this study, estimates for the shape (β) and scale (Θ) parameters in the two-parameter Weibull distribution were obtained by using the maximum likelihood estimation method for progressively censored samples. This technique of Weibull parameter estimation is found in an article by Cohen. [4]

The data gathered in this project represent progressively censored samples. That is, tests run on some specimens are stopped before failure occurs. Progressive censoring occurs when tests are stopped at several different stages and removed from the study. The data collected for the reworked bearings included nine failures and 11 censored samples removed from the experiment at ten different stages. The new bearings (not reworked) study generated data which contained four failures and six censored samples removed from the experiment at four different stages. Censored samples provide important information in the estimation of the Weibull distribution parameters.

Once the maximum likelihood equations for the Weibull parameters were derived, a numerical solution was obtained through the use of the Newton- Raphson iterative method, a standard technique used in numerical analysis. This technique provided rapid convergence to the Weibull parameter estimates given below:

Study	β (Shape Parameter Estimate)	Θ (Scale Parameter) Estimate)
New Bearings	2.103	662.14
Reworked Bearings	1.844	473.07

Based on these derived parameters, statistical Wiebull plots of the generated data for both new and reworked bearings, employed in this study, are shown in Figure 18. Since fatigue life for rolling-contact bearings is generally expressed in millions of bearing revolutions, instead of hours or stress cycles, that was employed as the abscissa in this presentation. The new bearings curve (dashed) was significantly influenced by the two bearings that operated for 507 hours (730.1 x 10^6 rev.) without failure. When these two long-duration censored samples were taken into account in the statistical solution, the shape parameter, β, was changed considerably which produced the dashed curve as shown in Figure 18. This curve, although it does not exhibit the best fit through the four plotted new bearing failures (solid data points), should better represent a Weibull plot for new bearings like those endurance tested. Numerous tests and bearing failures would be required to improve the accuracy of the curve. As shown the reworked bearings solid curve fits the data points (open circles) much better. This is because there were more reworked bearing failures and no tests that ran considerably longer than any other tests without bearing failure.

Since bearing life dispersion exists, two points or locations on the Weibull curve

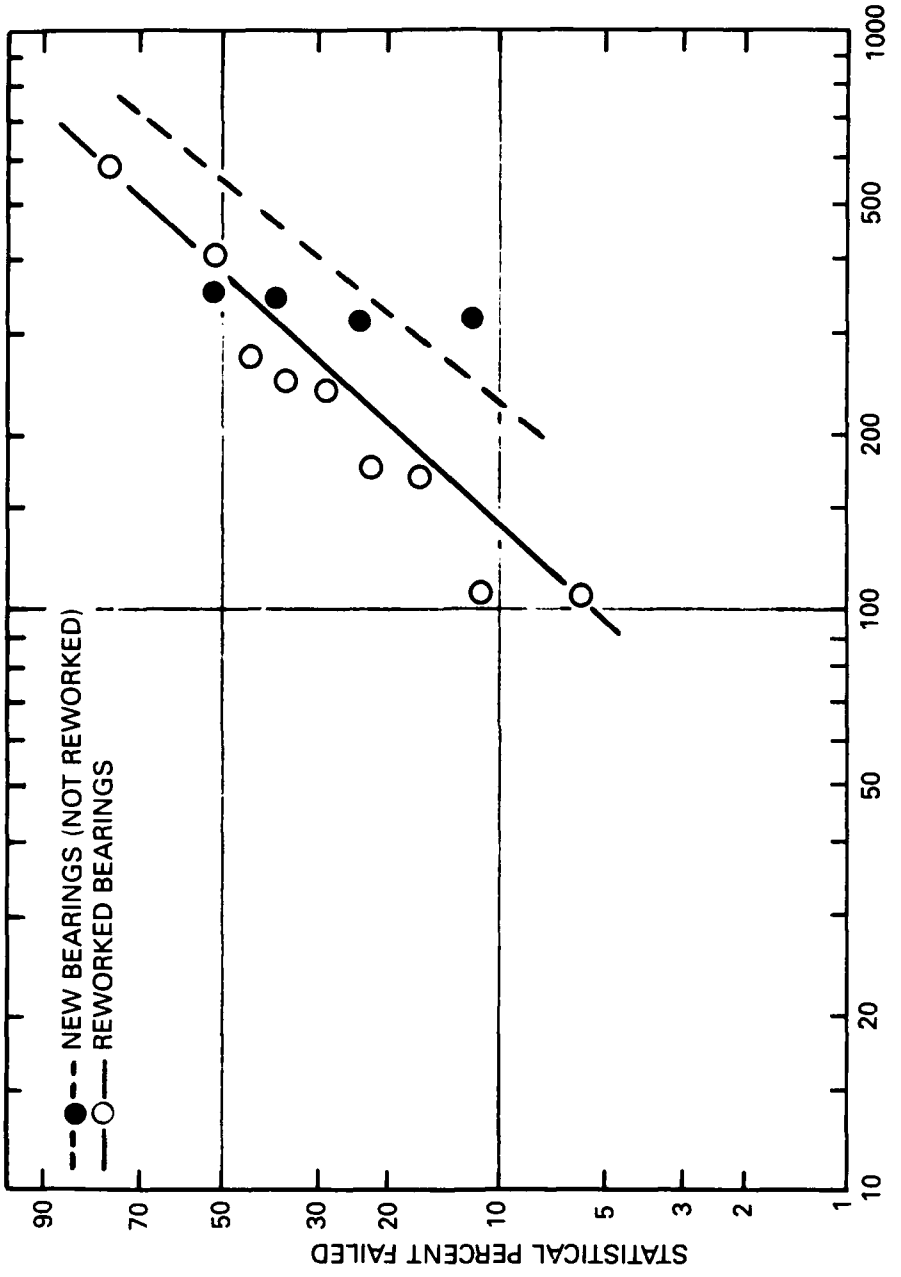


Figure 18: Weibull Plots Of Experimental Data For Bearings Tested At 24,000 RPM And 350,000 PSI Maximum Hertz Stress

for any bearing population have been chosen by bearing manufacturers to describe endurance. These are:

- L_{10} or B_{10} - the fatigue life which 90% of the bearing population will endure. Also known as the minimum life or rating life.
- L_{50} or B_{50} - the median life, or life which 50% of the bearing population will endure.

Comparing the curves for new bearings and reworked bearings shown in Figure 18 the bearing population lives, as defined above, are as follows:

Life Revolutions	New Bearings	Reworked Bearings
L_{10}	230×10^6	140×10^6
L_{50}	560×10^6	390×10^6

As seen from these data, both the L_{10} and L_{50} for the new bearings is approximately 1.5 times greater than for the reworked bearings. This indicates that some bearing life has been sacrificed in reworking this particular population of bearings. Normally, according to the bearing industry, the L_{50} (median life) for any group of "identical" bearings is approximately five times the L_{10} (minimum life). As seen in this study the new bearings displayed $L_{50} = 2.4\ L_{10}$ and the reworked bearing $L_{50} = 2.8\ L_{10}$. The reason for this discrepancy cannot be explained. It is suspected that the bearings were tested at a higher than recommended stress level, thus causing earlier than desired failures in several tests. Also, only a small number of data points were obtained, especially for the new bearings. Additional testing would probably alter the statistical analysis results and Weibull plots somewhat, and yield significantly improved bearing endurance life information and reliability.

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V CONCLUSIONS AND RECOMMENDATIONS

A Conclusions of Race Inspections

Based on the CIBLE inspection results, before and after regrind and the results of the endurance testing, the following conclusions have been drawn:

1. The CIBLE inspection results of the 1500 used races before regrind indicated 1341 of the 1500 races (89%) had only superficial surface damage or had no flaws at all. The damage was usually corrosion or scratches which could be removed by polishing or honing the race. It is concluded these races did not need regrinding.

2. The number of races with only magnetic perturbation circumferential signals,which indicates subsurface flaws, decrease only 27% from 82 before regrind to 60 after regrind. It is concluded that regrinding is not effective in removing these flaws.

3. Comparing the CIBLE inspection results from new ITI outer races with reground Fafnir and New Departure outer races show the ITI races have a very high percentage of races (59%) with magnetic perturbation circumferential signals. This indicates subsurface flaws or inclusions. It is concluded that the ITI outer races were made from material which was not as clean as the Fafnir or New Departure material.

4. ITI had many problems in regrinding these bearings. Bearing assemblies which qualify as reground used bearings represent only 56% of the 444 bearing assemblies returned from ITI. The bearings which were assembled from used inner races and new ITI outer races can not be considered to be representative of reground used bearings. It is concluded that results from this group of bearings should not be used to judge the process of regrinding bearings for reuse, since it is most likely not representative of the regrinding process.

5. Residual stress changes in bearing (S07501), which were detected by the Barkhausen Noise Analysis method, were not removed by regrinding. This race failed early during endurance testing. It is concluded that regrinding does not guarantee that races with residual stress changes will be restored to the original condition.

B Conclusions of Bearing Endurance Testing

Based on the bearing endurance testing performed in this study, the following conclusions are drawn:

1. A thrust bearing tester having capabilities of speeds up to 24,000 rpm and thrust loads up to 20,000 lbs has been successfully developed and operated for approximately 2,200 hours with minimal maintenance and upkeep. This tester is available for further high- speed bearing testing.

2. Endurance tests on both new and reworked bearings have been performed employing the bearing tester. Based on these tests, for the two particular populations of bearings used, it was found that the new bearings exhibited L_{10} (minimum life) and L_{50} (median life) approximately 1.5 times those for the reworked bearings. Also, two of the new bearings ran beyond the limiting 500-hour "shutoff" duration without failure, whereas none of the reworked bearings exhibited this capability. Based on these findings it is concluded that the new bearings have superior endurance capabilities over the reworked bearings.

3. It is also concluded that the spall failures in this study were indeed fatigue initiated and not debris-indentation initiated spalls. This conclusion is founded by the fact that the support bearings in the test-bearing heads were lubricated with the same oil as used to lubricate the test bearings. The entire 19 tests were run without replacement of any support bearings. This is calculated to be 2,612 million and 2,348 million revolutions on the support bearings in test- bearing heads 1 and 2, respectively without one support bearing failure. Surely, a debris-indentation problem associated with either of the lubrication systems would have caused support bearing failures in this large number of revolutions.

C Recommendations

1. Automated bearing inspection processes should be used to reduce the number of bearings rejected at CCAD for superficial damage or corrosion. Bearings should not be rejected for flaws which are not in or near the load zone. Better inspection systems at CCAD would reduce the need for the regrinding of races.

2. Races which have detected superficial corrosion or damage should not be reground but should be polished or honed to remove the damage. Races should be reinspected to confirm results.

3. Races with large magnetic perturbation circumferential signals in the load zone should be scraped since it is likely regrinding will not remove the flaw.

4. Barkhausen noise analysis should be used to detect stresses associated with overload or grinding burns since these problems may go undetected by other NDE methods.

5. A program to endurance test high service hour bearings which have no flaws should be undertaken to determine how much fatigue life is left in a flaw-free used bearing.

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APPENDIX A

BEARING PROCESSING AND INSPECTION

APPENDIX A

I Bearing Processing

The processing of bearings being inspected at SwRI requires a clean environment for disassembly, inspection and reassembly. Systems to identify and store bearings after disassembly are required since each bearing is a matched set and must be reassembled using the original components. Figure 1 is a block diagram showing the flow of the inspection procedure. The following discussion describes in detail each step in the inspection process.

An ultrasonic cleaning tank for cleaning disassembled bearing components and three additional dip tanks for secondary cleaning, fingerprint remover, and light oil preservative are available for bearing processing operations (see Figure 2). Space immediately adjacent to the cleaning area is available for packaging bearings. Entry to the bearing cleaning and packaging area, which is both temperature and humidity controlled, is through double-door access. Procedures to clean, preserve, package, and pack bearings are as specified in Form 872 of the subject contract.

All unpackaged bearing assemblies and/or components are handled with plastic gloves worn by the operator, and each bearing received is logged according to date received, part number, serial number, manufacturer, and its status (new, serviceable, or condemned) and the source from which it was received. In addition, the date of shipment of each bearing and its destination is entered in the log after it is inspected and repacked. On initial receipt, each bearing is assigned a serial number (in accordance with paragraph 4.2 of Engineering Specification MME3100-578 of the subject contract) that is vibratory etched on the face of the inner (both halves if a split race) and outer races. The number assigned is as follows:

- the letter "S" followed by,
- a four-digit number followed by,
- a one-digit number, either a "1" or "2", to uniquely identify each bearing in a duplex set; if not a duplex set, this last digit will always be a "zero".
- in some cases, a letter may follow the last (5th) digit as an additional designator (as yet undefined).

In addition, a circumferential location reference mark is vibratory etched across the face (a noncritical region) of the inner (both halves if a split race) and outer races of each bearing.

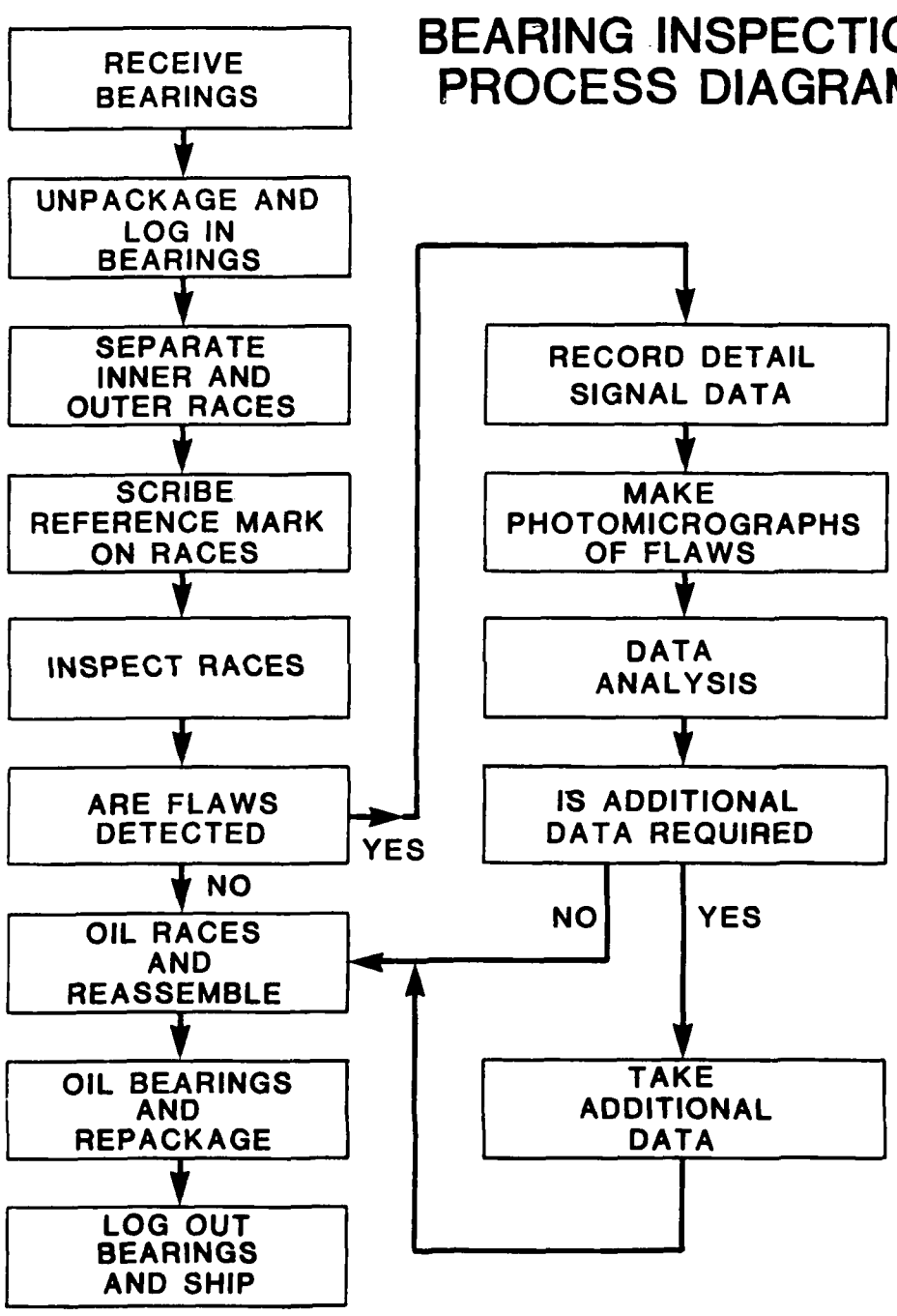

Figure 1: Bearing Inspection Process Diagram

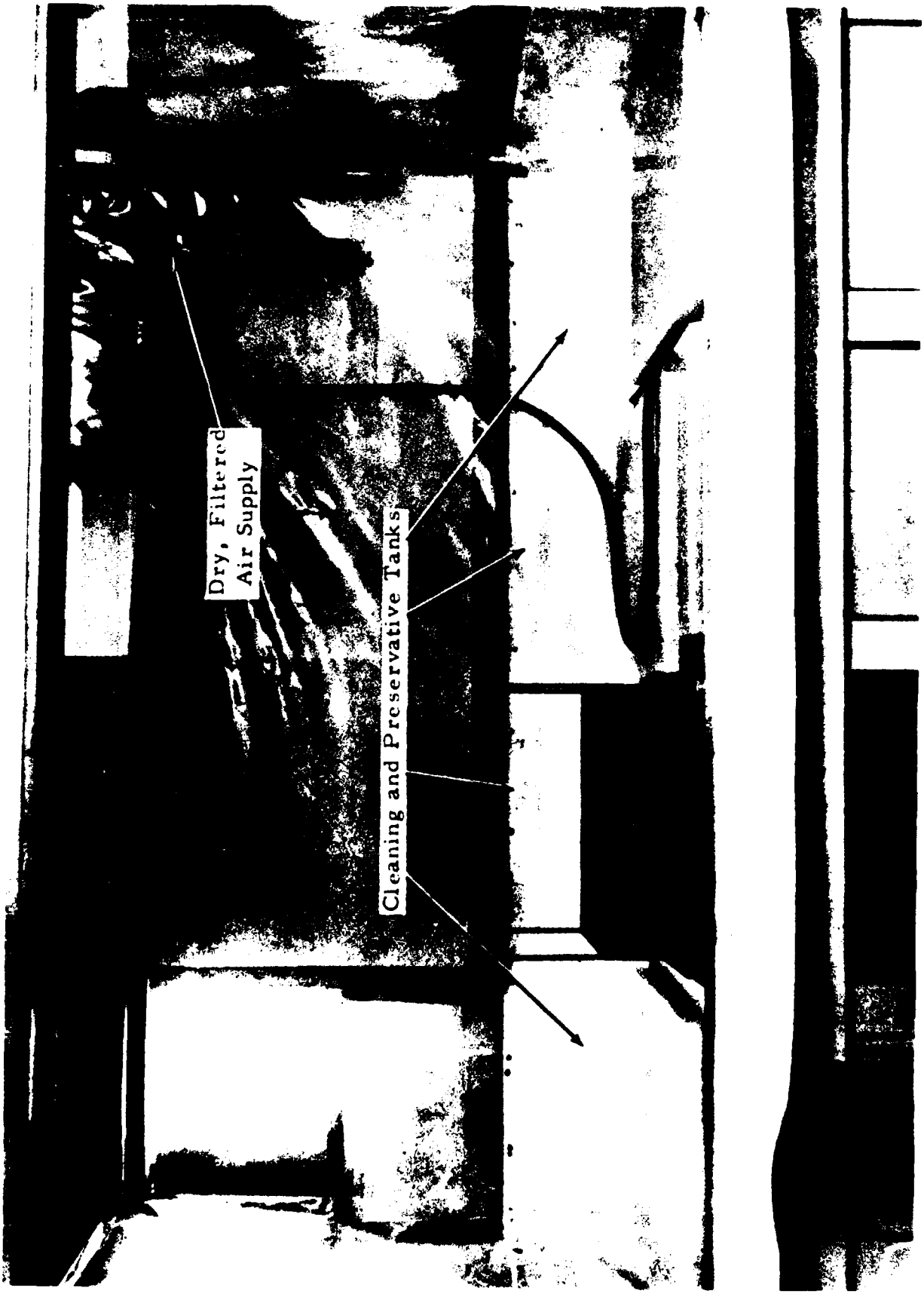

Figure 2: View of Bearing Cleaning Area

II Bearing Inspection

The inspection of T53 engine bearings P/N 1-300-015-02 and 1-300-005-04 inner and outer races is conducted using the Army CIBLE system (see Figure 3) which performs magnetic perturbation (radial and circumferential flux orientations) and Barkhausen noise inspections under computer supervision. Data from all inspections can be recorded on analog magnetic tape; simultaneously "threshold level" detection* signal analysis is performed automatically and the type and location (azimuthal and transverse) of all signals, which exceed the threshold level, are printed out in hard copy on the teleprinter. A closeup view of the bearing inspection unit is shown in Figure 4. In this view the cover on the inspection unit has been opened and a microscope (with camera) for visual correlation examination is mounted and the cover is closed to maintain a clean atmosphere at slight "positive" pressure in the cabinet to provide safety for the operator and to exclude external light interference with the laser scattered light inspection.

Magnetic perturbation inspection consists of applying radially and circumferentially oriented magnetic fields to a bearing component and sensing disturbances in these applied fields caused by the presence of defects (inclusions, pits, indents, cracks, etc.,) in the component. Radial field inspection is primarily sensitive to surface imperfections while circumferential field is more sensitive to defects near but beneath the surface. The strength of the applied field is also important. Inspections conducted with strong applied fields (near magnetic saturation) provide excellent sensitivity to geometrical type flaws (inclusions, pits, etc.,); similar inspections conducted at reduced fields enhance the detectability of flaws having associated localized stesses (fatigue cracks, indents, etc.,). Magnetic perturbation inspections have been conducted previously, using laboratory equipment on limited lot sizes of bearings. † As a result of this work

- direct correlations between signal locations and corresponding inclusion locations was established through metallurgical sectioning;
- a predictable relationship between a specific circumferential signal feature (peak-separation) and depth of an inclusion beneath the raceway surface was confirmed;
- influences of actual bearing service on flaw signal amplitudes were observed;
- direct correlation between the location of certain flaw signals, obtained prior to endurance testing, and the location of subsequent failure initiation was obtained.

Barkhausen noise inspection, at its present stage of development, provides a qualitative indication (and under certain conditions, a quantitative measure) of the state

*The term "threshold level" detection refers to a simple signal detection approach wherein a signal is "recognized" when it has an amplitude which exceeds a preset voltage (threshold amplitude or level).

†Work conducted under Air Force Contract No. F09603-69-C-5101 and NASA Contract No. NAS3-13944

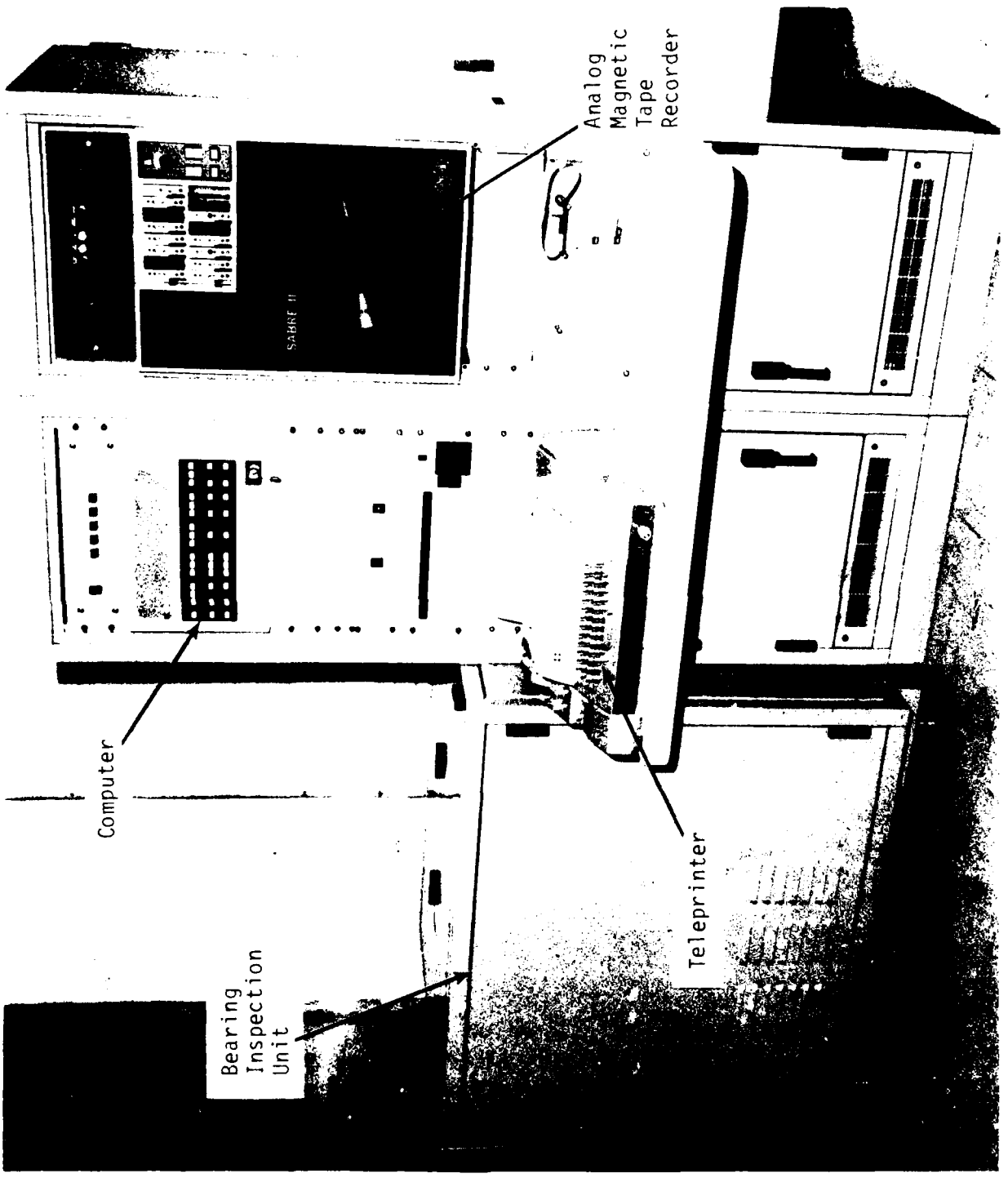

Figure 3: Overall View of SwRI Bearing Inspection System

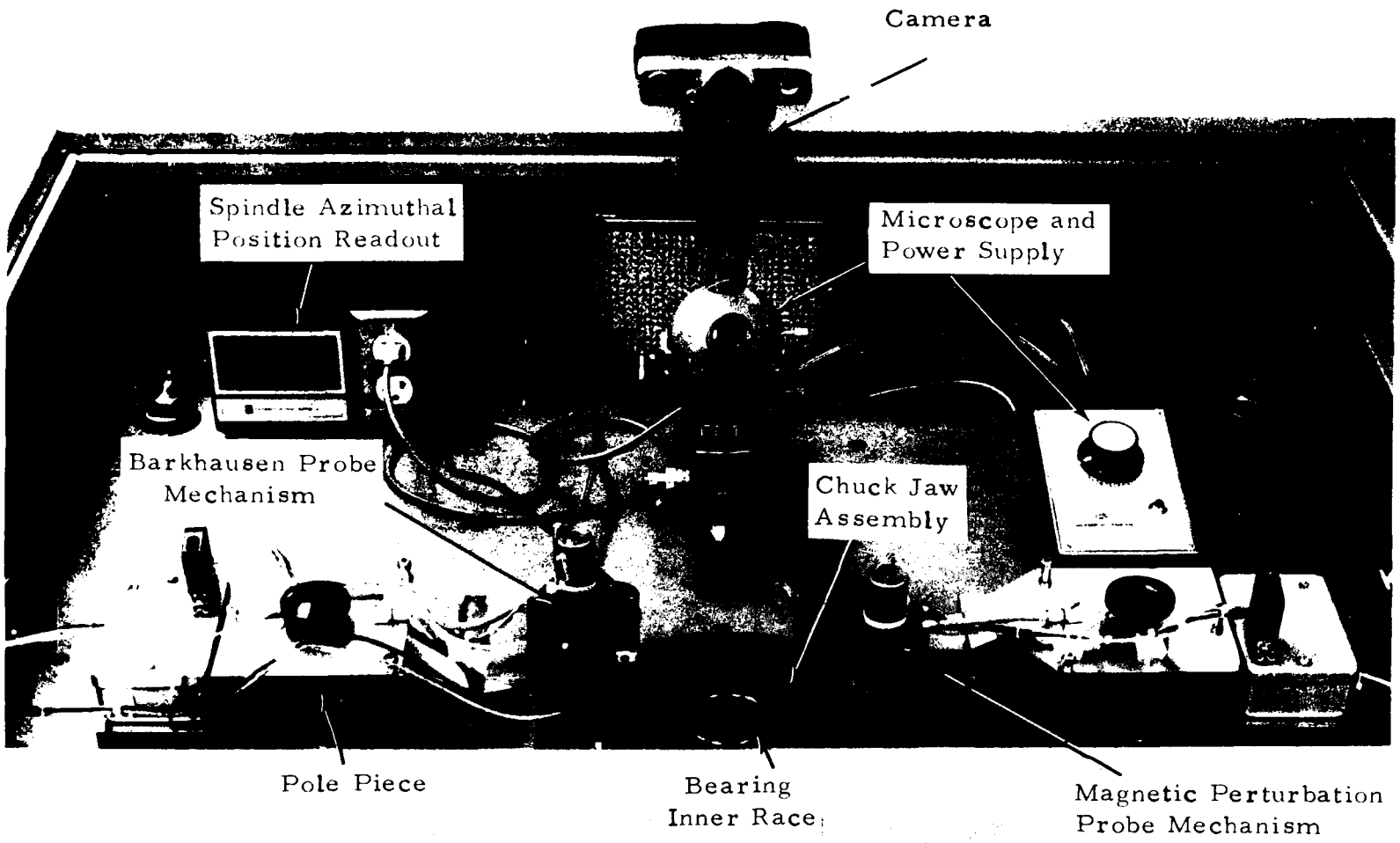

Figure 4: Closeup View of SwRI Bearing Inspection Head

of residual stress in ferromagnetic metals. The inspection is conducted by applying a controlled, time- varying magnetic field to the part under inspection; the resulting Barkhausen noise pulses induced to a sensing coil are electronically processed. Generally, it has been observed in the laboratory that tensile stresses (either residual or applied) result in a high amplitude "process" Barkhausen signature; compressive stresses produce a low amplitude signature. In the case of new ball bearings, usually low amplitude signatures have been observed; after subsequent service, however, a change in the Barkhausen signatures from some of these bearings was noted which indicated a decrease in residual compression stress.[‡] Importantly, a reduction in near surface compressive stresses could result in reduced bearing service life.

A brief description of a typical inspection sequence follows. The operator enters descriptive information, via the terminal keyboard, about the bearing component to be inspected. Based on this input information, the computer instructs the operator as to the fixturing (race chucking, magnetizing and sensing elements) to be mounted and the inspection parameter tape (punched tape, hereafter referred to a P-tape) to be loaded via a paper tape reader. The P-tape enters into the computer memory the necessary parameters to accomplish an automatic inspection on the specified bearing component, and essentially all remaining inspections steps are automatic.

The operator is instructed via the teleprinter to load the bearing component, and close the loading access door. Subsequently, the bearing is clamped via an air chuck, the spindle is raised to the inspect position, air is turned on to produce air coupling between the probes and the bearing component, and the pole pieces are brought into proximity to the bearing race. The race is rotated at a programmed speed to obtain a surface speed of 90 inches per second. The reference line on the face of the bearing is sensed with an optical pick-up head; the computer stores the location of the bearing reference mark with respect to the spindle shaft encoder reference. When reference line location is acquired, the magnetic perturbation inspection sequence proceeds.

A programmed high field current[§] is applied to the magnetizing coils and the radial and circumferential probes are simultaneously stepped to adjacent scan tracks. Each scan track covers a strip of surface around the circumerence of the bearing which is 0.025 inches wide. The probe is stepped to 0.02 inches to the adjacent track, providing a slight overlap in the scan. The number of steps between tracks and the total number of tracks inspected are supervised by the computer from information contained in the P-tape. Each track is scanned for three revolutions; the signal data from which are

[‡]Work conducted under Air Force Contract No. F09603-70-C-5547.

[§]Conducting the high field inspection first assures that the prior unknown magnetic history of the specimen does not randomly influence inspection results

recorded on an analog magnetic tape recorder. The scan track and azimuthal locations of signals exceeding a preset threshold level are stored in the computer (in a buffer) for later printout. On completion of all track locations at high magnetic field, the radial and circumferential probes are automatically returned to "track zero". The magnetizing field is decreased to a preprogrammed low field current, the probe scan tracks are repeated, and the data are recorded on magnetic tape. Locations of signals exceeding a threshold at low field are also stored in the computer. The magnetic perturbation probes are returned to track zero, the magnetizing current is programmed to zero, spindle rotation is programmed to zero, and the type (radial or circumferential and high or low field) and location of signals exceeding the preset threshold levels are printed out. The operator is instructed to reduce the selected magnetic tape transport speed for the subsequent Barkhausen noise inspection.

III Barkhausen Noise Inspection

The bearing is rotated automatically until the Barkhausen probe is in alignment with the reference mark on the bearing, the magnetizing power supplies are reconfigured so that a controlled, time-varying current is applied to the magnetizing coils. Barkhausen signatures are recorded and monitored for three successive magnetization cycles at each of three transverse probe locations. Subsequently, this inspection sequence is repeated at azimuthal positions 120 degrees and 240 degrees from the initial position, respectively. The operator is then instructed to increase the selected tape.

IV Demagnetization

The bearing component is then automatically demagnetized by reconfiguring the magnetizing power supplies, applying high field followed by programming the field to zero while rotating the bearing, subsequently withdrawing the pole pieces, and lowering the spindle. Subsequent to demagnetization, the location of signals exceeding the preset threshold criteria for the Barkhausen noise inspection are printed out.

V Other Inspection Mode Options

Upon completion of the automatic inspection sequence on a bearing from which "flaw" printouts are obtained, the operator is given several options:

- to conduct a visual inspection,
- to repeat any one or more of the inspections in a manual mode, or
- to return the automatic mode for any one or more of the three types of inspections.

A visual inspection is facilitated using the spindle azimuthal position readout and positioning micrometers on the microscope assembly in conjunction with the signal or "flaw" printout.

APPENDIX B

PROCEDURE FOR SETTING UP AND UTILIZING VIBRATION SENSING "SHUTDOWN" ON ENDURANCE TESTS

APPENDIX B

Procedure for Setting Up and Utilizing Vibration Sensing "Shutdown" on Endurance Tests

This procedure applies to the vibration sensing system consisting of an accelerometer on each test bearing head and a variable trigger level network associated with each particular accelerometer.

The test bearings are assembled into their respective test bearing head and coupled to the drive system. The vibration detector mode selector switches for both systems are the "Inhibit" positions so rig startup can be accomplished. With the rig running the threshold controls (dial readings) are increased until no alarms are obtained (with the systems in the "inhibit" modes.) These settings are called the "threshold" levels (TL1 for each system). Record these readings. Increase dial readings, on each system by 5 points (1 turn = 100 points) and monitor the alarm lamps for five minutes. If no alarms are obtained during this test interval, the dial settings are increased by 10 additional points. These settings are called the "operate" levels (OL1 for each system). Record these readings. The mode selector switches are then placed in the "Operate" positions.

If automatic shutdown occurs before the prescribed endurance test duration is completed, and because of alarms other than vibration alarm, the following procedure should be used. Place the mode selector switch in "Inhibit" positions and restart the testers without changing operate level settings (OL1's). Reset alarm lamps and note if lamps relight; if alarms do not reoccur for five minutes continue run at OL1's and place selector switches in "Operate" positions. If lamps relight, reset and monitor several times to check that alarms are repeatable; if alarms are repeatable follow procedure below. With selectors in "Inhibit", increase threshold dial settings until no alarms occur. These are new threshold levels (TL2's). Record these new readings and proceed to new "Operate" levels exactly as described above.

Any time that automatic shutdown is initiated by an alarm lamp, remove that test bearing head from the drive system and disassemble for test bearing inspection and test termination. Continue testing with other test bearing head, after resetting new "Operate" level, (assuming alarm lamp was not actuated) until automatic vibration shutdown for that particular tester is actuated (as indicated by alarm lamp). At that time, this tester will be disassembled for test termination, and test bearing inspection. If 500 hours of testing are completed without vibration shutdown, the endurance test is terminated and test bearing inspection performed.

APPENDIX C

BEARING ENDURANCE TEST REPORT
1-300-015-(02/04)

BEARING ENDURANCE TEST REPORT
1-300-015-(02/04)

Test	Bearing S/N	Service Hours	Mfgr.	New/ Reworked	Reason Selected	Test Hours	Results
	712BC		FAF	N	No Flaw in Load Track	105.3	STOPPED-High Vibration Level
	IR	*0000*					*BK Change*
	OR	*0000*					*Indents*
	Balls	*0000*					*Indents*
1							
	J0 682		FAF	N	No Flaw in Load Track	105.3	
	IR	*0000*					*BK Change*
	OR	*0000*					*Indents*
	Balls	*0000*					*Indents*
	R965AH		FAF	R	No Flaw in Load Track	123.2	STOPPED-High Vibration Level
	IR	*1539*					*Indents/BK Change*
	OR	*1737*					*Indents*
	Balls	*0000*					*Indents*
2							
	R289AN		FAF	R	No Flaw in Load Track	123.2	
	IR	*0476*					*Spall*
	OR	*Unk*					*Indents*
	Balls	*0000*					*Indents*
	J0683		FAF	N	No Flaw in Load Track	507.00	TEST COMPLETED WITHOUT FAILURE
	IR	*0000*					–
	OR	*0000*					–
	Balls	*0000*					–
3							
	J0696		FAF	N	No Flaw in Load Track	507.00	
	IR	*0000*					–
	OR	*0000*					–
	Balls	*0000*					–
	R343AM		FAF	R	No Flaw in Load Track	411.7	STOPPED-High Vibration Level
	IR	*Unk*					*Indents, BK Change*
	OR	*1885*					*Indents, BK Change*
	Balls	*0000*					*Indents*
4							
	R375AF		FAF	R	No Flaw in Load Track	411.7	
	IR	*1483*					*Spalls*
	OR	*1106*					*Indents*
	Balls	*0000*					*Indents*

BK=Barkhausen; CH=Circumferential High Field; CL=Circumferential Low Field
RH=Radial High Field; RL=Radial Low Field; R=Reworked; N=New
FAF=Fafnir; ND=New Departure

Test	Bearing S/N	Service Hours	Mfgr.	New/ Reworked	Reason Selected	Test Hours	Results
5	R270		ND	R	Large CH Indication	24.5	STOPPED-High Vibration Level
	IR	*521*					–
	OR	*521*					*BK Change*
	Balls	*0000*					*Spall*
	R24409		ND	R	Small CH Indication	24.5	
	IR	*1647*					*BK Change*
	OR	*1647*					*Indents, BK Change*
	Balls	*0000*					–
6	R6081		ND	R	Large CH Indication	165.6	STOPPED-High Vibration Level
	IR	*0870*					*Spall*
	OR	*0870*					*Indents, BK Change*
	Balls	*0000*					–
	R6827		ND	R	CH Indication	165.6	
	IR	*0599*					*Indents, BK Change*
	OR	*0599*					*Indents, BK Change*
	Balls	*0000*					*Spall-Large*
7	R3090		ND	R	Large CH Indication	20.5	STOPPED-High Vibration Level
	IR	*Unk*					*Indents, BK Change*
	OR	*Unk*					*BK Change*
	Balls	*0000*					–
	R17719		ND	R	RH Indication	20.5	
	IR	*0490*					*BK Change*
	OR	*0569*					*Indents, BK Change*
	Balls	*0000*					–
8	J0698		FAF	N	No Flaw in Load Track	245.8	STOPPED-High Vibration Level
	IR	*0000*					*Indents*
	OR	*0000*					*Indents*
	Balls	*0000*					*Indents*
	J0705		FAF	N	No Flaw in Load Track	245.8	
	IR	*0000*					*Indents/Groove Around Race*
	OR	*0000*					*Spall*
	Balls	*0000*					*Indents*

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FAF=Fafnir; ND=New Departure

Test	Bearing S/N	Service Hours	Mfgr.	New/ Reworked	Reason Selected	Test Hours	Results
	J0711		FAF	N	No Flaw in Load Track	237.3	STOPPED-High Vibration Level
	IR	*0000*					*Spall*
	OR	*0000*					*Indents*
	Balls	*0000*					*Indents*
9							
	J0718		FAF	N	No Flaw in Load Track	237.3	
	IR	*0000*					*Indents*
	OR	*0000*					*Indents*
	Balls	*0000*					*Indents*
	445BA		FAF	N	No Flaw in Load Track	219.1	STOPPED-High Vibration Level
	IR	*0000*					*Indents*
	OR	*0000*					*Spall*
	Balls	*0000*					*Mini Spalls, Indents*
10							
	J0729		FAF	N	No Flaw in Load Track	219.1	
	IR	*0000*					*Spall*
	OR	*0000*					*Spall*
	Balls	*0000*					*Indents*
	R1731		FAF/ ITI	R	CH Indication	172.6	STOPPED-High Vibration Level
	IR	*1621*					*Mini Spalls, Indents*
	OR	*0000*					*Mini Spalls, Indents*
	Balls	*0000*					*Mini Spalls, Indents*
11							
	R5411AS		FAF	R	RH, RL Indication	172.6	
	IR	*0418*					*Mini Spalls, Indents*
	OR	*0933*					*Spall*
	Balls	*0000*					*Mini Spalls, Indents*
	R543AH		FAF/ ITI	R	CH Indication	296.1	STOPPED-High Vibration Level
	IR	*Unk*					*Indents, Pits*
	OR	*0000*					*Indents*
	Balls	*0000*					*Spalls*
12							
	R778P		FAF	R	CH Indication	296.1	
	IR	*0994*					*Indents*
	OR	*2643*					*Pits*
	Balls	*0000*					*Indent*

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FAF=Fafnir; ND=New Departure

Test	Bearing S/N	Service Hours	Mfgr.	New/ Reworked	Reason Selected	Test Hours	Results
	R159AH		FAF	R	RH, CH Indication	73.6	STOPPED-High Vibration Level
	IR	*2187*					*Spall*
	OR	*0300*					*Indents*
	Balls	*0000*					*Indents*
13							
	R966AH		FAF ITI	R	RH, RL Indications	73.6	
	IR	*0650*					*Indents*
	OR	*0000*					*Indents*
	Balls	*0000*					*Mini Spall, Indents*
	R1084		FAF	R	RH, RL Indications	190.6	STOPPED-High Vibration Level
	IR	*1343*					*Indents*
	OR	*0884*					*Indents*
	Balls	*0000*					*Spall-sm, Indents*
14							
	R243AC		FAF/ ITI	R	CH Indication	190.6	
	IR	*3351*					*Indents*
	OR	*0000*					*Indents*
	Balls	*0000*					*Spall-lg, Indents*
	R5599AS		FAF	R	No Flaw in Load Track	282.5	STOPPED-High Vibration Level
	IR	*1022*					*Spall BR 1369 to 1388 ST03 & Others*
	OR	*Unk*					*Indents*
	Balls	*0000*					*Mini Spall, Indents*
15							
	R987AP		FAF	R	No Flaw in Load Track	282.5	
	IR	*Unk*					*Corr Pits*
	OR	*0925*					*Sm Pits*
	Balls	*0000*					*Indents*
	R370		FAF/ ITI	R	CH Indication	10.8	STOPPED-High Vibration Level
	IR	*1025*					-
	OR	*0000*					-
	Balls	*0000*					*Mini Spalls, Indents*
16							
	R638A0		FAF/ ITI	R	RH, RL Indications	10.8	
	IR	*1046*					-
	OR	*0000*					Indents
	Balls	*0000*					*Mini Spall, Indents*

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RH=Radial High Field; RL=Radial Low Field; R=Reworked; N=New
FAF=Fafnir; ND=New Departure

Test	Bearing S/N	Service Hours	Mfgr.	New/ Reworked	Reason Selected	Test Hours	Results
	R4124		FAF	R	BK Indication	73.4	STOPPED-High Vibration Level
	IR	*0727*					*Indents, BK Change*
	OR	*0608*					*Indents, BK Change*
	Balls	*0000*					*Indents, BK Change*
17							
	(N)R9638AS		FAF/ ITI	R	BK Indication	73.4	
	IR	*Unk*					*Spall*
	OR	*0000*					*Indents, BK Change*
	Balls	*0000*					*Spall-lg*
	(N)R1271		FAF/ ITI	R	BK Indication	167.0	STOPPED-High Vibration Level
	IR	*1926*					*Spall*
	OR	*0000*					*Indents*
	Balls	*0000*					*Indents*
18							
	R4638		FAF	R	BK Indication	167.0	
	IR	*1800*					*Indents, BK Change*
	OR	*0754*					*Indents, BK Change*
	Balls	*0000*					*Indents*
	R111T		FAF	R	BK Indication	118.1	STOPPED-High Vibration Level
	IR	*0300*					*Galling, BK Change*
	OR	*1500*					*Indents*
	Balls	*0000*					*Indents*
19							
	R3269AS		FAF	R	BK Indication	118.1	
	IR	*Unk*					*Indents, BK Change*
	OR	*0497*					*Indents, BK Change*
	Balls	*0000*					*Mini Spalls, Indents*

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FAF=Fafnir; ND=New Departure

APPENDIX D

TABLE OF MATERIAL REMOVED AND NEW BALL SIZE FOR REGROUND BEARINGS

Bearing Assembly	Outer race s/n	Inner race s/n	O/R dia.	O/R restored dia.	O/R stock removed	I/R dia.	I/R restored dia.	I/R stock removed	New ball dia.
R1034AS	R1034AS	1034AS	0.0000	0.0000	0.0000	2.2534	2.2491	.0043	.5029
R1064	R1064	1064	0.0000	0.0000	0.0000	2.2515	2.2499	.0016	.5029
R1077	1077	3054AS	3.2577	3.2636	.0059	2.2545	2.2508	.0037	.5040
R1077	R1077	1077	0.0000	0.0000	0.0000	2.2522	2.2494	.0028	.5029
R1084	1084	338	3.2595	3.2656	.0061	2.2580	2.2561	.0019	.5029
R108AD	108AD	449AG	3.2578	3.2635	.0057	2.2537	2.2510	.0027	.5043
R108AD	R108AD	108AD	0.0000	0.0000	0.0000	2.2523	2.2501	.0022	.5029
R110AN	110AN	4228AS	3.2578	3.2624	.0046	2.2530	2.2520	.0010	.5035
R1114AS	1114AS	2434	3.2593	3.2654	.0061	2.2590	2.2564	.0026	.5029
R111T	111T	1114AS	3.2580	3.2624	.0044	2.2535	2.2519	.0016	.5035
R111T	R111T	111T	0.0000	0.0000	0.0000	2.2528	2.2486	.0042	.5029
R113AL	R113AL	113AL	0.0000	0.0000	0.0000	2.2548	2.2441	.0107	.5029
R115Q	R115Q	115Q	0.0000	0.0000	0.0000	2.2524	2.2509	.0015	.5029
R1161AS	R1161AS	1161AS	0.0000	0.0000	0.0000	2.2544	2.2495	.0048	.5029
R12338	12338	16914	3.2740	3.2776	.0036	2.2716	2.2699	.0017	.5029
R125AD	R125AD	125AD	0.0000	0.0000	0.0000	2.2526	2.2472	.0054	.5029
R1271	R1271	1271	0.0000	0.0000	0.0000	2.2532	2.2499	.0033	.5005
R12730	12730	12730	3.2795	3.2840	.0045	2.2785	2.2762	.0023	.5029
R1302AS	1302AS	558AJ	3.2589	3.2645	.0056	2.2546	2.2528	.0018	.5043
R1302AS	R1302AS	1302AS	0.0000	0.0000	0.0000	2.2536	2.2497	.0039	.5029
R13140	13140	4135	3.2680	3.2727	.0047	2.2684	2.2651	.0033	.5029
R13459	13459	13459	3.2675	3.2716	.0041	2.2654	2.2626	.0028	.5035
R1370AS	1370AS	694AS	3.2602	3.2670	.0068	2.2598	2.2561	.0037	.5035
R138R	R138R	138R	0.0000	0.0000	0.0000	2.2525	2.2476	.0049	.5029
R1391	1391	103AC	3.2476	3.2549	.0073	2.2467	2.2455	.0012	.5029
R1391	R1391	1391	0.0000	0.0000	0.0000	2.2419	2.2381	.0038	.5029
R14023	14023	24495	3.2690	3.2719	.0029	2.2715	2.2645	.0070	.5029
R14023	R14023	14023	0.0000	0.0000	0.0000	2.2677	2.2630	.0047	.5035
R144AF	144AF	144AF	3.2576	3.2619	.0043	2.2535	2.2491	.0044	.5043
R144Q	R144Q	144Q	0.0000	0.0000	0.0000	2.2533	2.2489	.0044	.5029
R14594	14594	22774	3.2739	3.2773	.0034	2.2715	2.2694	.0021	.5029
R14594	R14594	14594	0.0000	0.0000	0.0000	2.2720	2.2669	.0051	.5035
R145Y	145Y	4124	3.2583	3.2632	.0050	2.2532	2.2508	.0024	.5045
R14634	14634	14634	3.2738	3.2774	.0036	2.2722	2.2700	.0022	.5029
R146AE	R146AE	146AE	0.0000	0.0000	0.0000	2.2441	2.2320	.0121	.5029
R1478	R1478	1478	0.0000	0.0000	0.0000	2.2536	2.2506	.0030	.5029
R147AD	R147AD	147AD	0.0000	0.0000	0.0000	2.2520	2.2463	.0057	.5029
R1508	1508	523L	3.2582	3.2635	.0053	2.2586	2.2543	.0043	.5029
R1508	R1508	1508	0.0000	0.0000	0.0000	2.2548	2.1492	.1056	.5029
R1549	1549	958	3.2587	3.2630	.0043	2.2584	2.2540	.0044	.5029
R1549	R1549	1549	0.0000	0.0000	0.0000	2.2540	2.2493	.0047	.5029
R15529	15529	15529	3.2741	3.2775	.0034	2.2720	2.2698	.0022	.5029
R15780	15780	15780	3.2742	3.2775	.0033	2.2715	2.2701	.0014	.5029
R159AH	159AH	2884	3.2580	3.2618	.0038	2.2534	2.2510	.0024	.5035
R16030	16030	16030	3.2745	3.2788	.0043	2.2728	2.2712	.0016	.5029
R16120	16120	16120	3.2742	3.2775	.0033	2.2712	2.2701	.0011	.5029
R1636	1636	3593AS	3.2586	3.2641	.0055	2.2546	2.2517	.0029	.5040
R1636	R1636	1636	0.0000	0.0000	0.0000	2.2532	2.2461	.0071	.5005
R1649AS	R1649AS	1649AS	0.0000	0.0000	0.0000	2.2543	2.2499	.0044	.5029
R16546	16546	16546	3.2740	3.2780	.0040	2.2720	2.2705	.0015	.5029
R16914	16914	3357	3.2735	3.2770	.0035	2.2714	2.2692	.0022	.5029

Bearing Assembly	Outer race s/n	Inner race s/n	O/R dia.	O/R restored dia.	O/R stock removed	I/R dia.	I/R restored dia.	I/R stock removed	New ball dia.
R1710	R1710	1710	0.0000	0.0000	0.0000	2.2588	2.2466	.0122	.5029
R1731	R1731	1731	0.0000	0.0000	0.0000	2.2546	2.2440	.0106	.5029
R17719	17719	2867	3.2745	3.2781	.0036	2.2727	2.2704	.0023	.5029
R179X	179X	192AR	3.2585	3.2654	.0069	2.2602	2.2554	.0048	.5035
R179X	R179X	179X	0.0000	0.0000	0.0000	2.2534	2.2477	.0057	.5029
R1814	1814	1822	3.2735	3.2765	.0030	2.2698	2.2677	.0021	.5035
R1821	R1821	1821	0.0000	0.0000	0.0000	2.2482	2.2440	.0042	.5029
R18250	18250	18250	3.2738	3.2779	.0041	2.2718	2.2702	.0016	.5029
R1854	R1854	1854	0.0000	0.0000	0.0000	2.2482	2.2416	.0066	.5005
R1856	1856	1856	3.2732	3.2763	.0031	2.2720	2.2688	.0032	.5029
R1856AS	1856AS	4132	3.2584	3.2622	.0038	2.2532	2.2497	.0035	.5043
R1856AS	R1856AS	1856AS	0.0000	0.0000	0.0000	2.2535	2.2503	.0032	.5029
R18719	18719	18719	3.2793	3.2828	.0035	2.2781	2.2750	.0031	.5029
R1882	1882	1882	3.2739	3.2779	.0040	2.2700	2.2672	.0028	.5040
R18908	18908	18908	3.2743	3.2780	.0037	2.2724	2.2706	.0018	.5029
R1909	1909	1909	3.2737	3.2777	.0040	2.2701	2.2691	.0010	.5035
R1914	1914	1914	3.2742	3.2774	.0032	2.2708	2.2695	.0013	.5029
R19416	19416	19416	3.2790	3.2824	.0034	2.2766	2.2747	.0019	.5029
R1945	R1945	1945	0.0000	0.0000	0.0000	2.2492	2.2452	.0040	.5029
R195AS	195AS	489AE	3.2583	3.2635	.0052	2.2548	2.2511	.0037	.5043
R1963AS	1963AS	131W	3.2592	3.2642	.0050	2.2530	2.2518	.0012	.5040
R197E	197E	305AS	3.2580	3.2630	.0050	2.2541	2.2507	.0034	.5045
R197E	R197E	197E	0.0000	0.0000	0.0000	2.2533	2.2496	.0037	.5029
R20039	20039	2430AS	3.2582	3.2636	.0054	2.2531	2.2510	.0021	.5040
R2020	2020	2283AS	3.2539	3.2638	.0099	2.2538	2.2518	.0020	.5043
R2028	2028	2028	3.2736	3.2773	.0037	2.2705	2.2685	.0020	.5035
R2028AS	2028AS	322AD	3.2475	3.2538	.0063	2.2454	2.2431	.0023	.5035
R203Z	R203Z	203Z	0.0000	0.0000	0.0000	2.2572	2.2433	.0139	.5005
R205AC	205AC	159AH	3.2577	3.2622	.0045	2.2547	2.2500	.0047	.5045
R205G	R205G	205G	0.0000	0.0000	0.0000	2.2530	2.2455	.0075	.5005
R2075	R2075	2075	0.0000	0.0000	0.0000	2.2433	2.2425	.0008	.5029
R2085	2085	709AO	3.2480	3.2550	.0070	2.2520	2.2445	.0075	.5035
R2085	R2085	2085	0.0000	0.0000	0.0000	2.2445	2.2425	.0020	.5029
R2131AS	2131AS	5368AS	3.2581	3.2639	.0058	2.2542	2.2531	.0011	.5035
R2131AS	R2131AS	2131AS	0.0000	0.0000	0.0000	2.2530	2.2523	.0007	.5005
R215AF	215AF	753AS	3.2530	3.2584	.0054	2.2469	2.2459	.0010	.5043
R215AF	R215AF	215AF	0.0000	0.0000	0.0000	2.2526	2.2425	.0101	.5005
R2168AS	2168AS	734AN	3.2585	3.2647	.0062	2.2591	2.2544	.0047	.5035
R2182	2182	4430AS	3.2580	3.2650	.0070	2.2645	2.2550	.0095	.5035
R21845	21845	21845	3.2745	3.2780	.0035	2.2725	2.2706	.0019	.5029
R218AP	R218AP	218AP	0.0000	0.0000	0.0000	2.2532	2.2461	.0071	.5029
R218Y	218Y	437AM	3.2580	3.2635	.0055	2.2534	2.2533	.0001	.5035
R218Y	R218Y	218Y	0.0000	0.0000	0.0000	2.2532	2.2482	.0050	.5029
R22189	R22189	22189	0.0000	0.0000	0.0000	2.2720	2.2669	.0051	.5035
R2223	R2223	2223	0.0000	0.0000	0.0000	2.7030	2.2560	.0155	.5035
R2223	2223	22565	3.2659	3.2704	.0045	2.2703	2.2622	.0081	.5029
R2226	2226	2226	3.2738	3.2773	.0035	2.2706	2.2696	.0010	.5029
R2244	2244	912X	3.2585	3.2628	.0045	2.2593	2.2507	.0084	.5045
R2244	R2244	2244	0.0000	0.0000	0.0000	2.2547	2.2414	.0133	.5005
R22514	22514	22514	3.2737	3.2773	.0036	2.2717	2.2695	.0022	.5029
R2254	2254	3731	3.2581	3.2645	.0064	2.2542	2.2518	.0024	.5043
R2254	R2254	2254	0.0000	0.0000	0.0000	2.2543	2.2481	.0062	.5029

Bearing Assembly	Outer race s/n	Inner race s/n	O/R dia.	O/R restored dia.	O/R stock removed	I/R dia.	I/R restored dia.	I/R stock removed	New ball dia.
R22598	22598	22598	3.2743	3.2778	.0035	2.2716	2.2701	.0015	.5029
R2274	2274	2274	3.2738	3.2771	.0033	2.2710	2.2695	.0015	.5029
R22774	22774	1814	3.2737	3.2770	.0033	2.2706	2.2691	.0015	.5029
R22836	22836	22836	3.2742	3.2773	.0031	2.2724	2.2696	.0028	.5029
R230AL	R230AL	230AL	0.0000	0.0000	0.0000	2.2399	2.2308	.0091	.5005
R2318	2318	23638	3.2754	3.2798	.0044	2.2716	2.2706	.0010	.5035
R23243	23243	5737	3.2738	3.2771	.0033	2.2710	2.2685	.0025	.5035
R2325	2325	2325	3.2740	3.2772	.0032	2.2709	2.2696	.0013	.5029
R23317	23317	23317	3.2734	3.2764	.0030	2.2710	2.2689	.0021	.5029
R23356	R23356	23356	0.0000	0.0000	0.0000	2.2698	2.2652	.0046	.5035
R2344AS	R2344AS	2344AS	0.0000	0.0000	0.0000	2.2539	2.2495	.0044	.5029
R23467	23467	23467	3.2721	3.2754	.0033	2.2697	2.2676	.0021	.5029
R2358	R2358	2358	0.0000	0.0000	0.0000	2.2540	2.2484	.0056	.5029
R23582	23582	23582	3.2735	3.2769	.0034	2.2711	2.2695	.0016	.5029
R235T	235T	856AG	3.2577	3.2628	.0051	2.2542	2.2511	.0031	.5043
R23636	R23636	23636	0.0000	0.0000	0.0000	2.2713	2.2665	.0048	.5035
R23792	23792	23792	3.2747	3.2784	.0037	2.2724	2.2708	.0016	.5029
R2382AS	2382AS	803G	3.2588	3.2634	.0046	2.2538	2.2528	.0010	.5035
R2382AS	R2382AS	2382AS	0.0000	0.0000	0.0000	2.2530	2.2508	.0022	.5029
R238AO	R238AO	238AO	0.0000	0.0000	0.0000	2.2542	2.2476	.0066	.5029
R2390AS	R2390AS	2390AS	0.0000	0.0000	0.0000	2.2520	2.2442	.0078	.5029
R2391	2391	2391	3.2736	3.2771	.0038	2.2706	2.2696	.0010	.5029
R2393AS	2393AS	2393AS	3.2580	3.2621	.0041	2.2535	2.2516	.0019	.5035
R2414	R2414	2414	0.0000	0.0000	0.0000	2.2715	2.2660	.0055	.5035
R241AX	R241AX	241AX	0.0000	0.0000	0.0000	2.2534	2.2484	.0050	.5029
R24257	24257	24257	3.2734	3.2774	.0040	2.2717	2.2668	.0049	.5040
R2430AS	2430AS	2731	3.2583	3.2631	.0048	2.2540	2.2510	.0010	.5045
R24349	24349	24349	3.2747	3.2785	.0038	2.2724	2.2705	.0019	.5029
R243AC	R243AC	243AC	0.0000	0.0000	0.0000	2.2478	2.2442	.0036	.5029
R24409	24409	24409	3.2670	3.2706	.0036	2.2641	2.2627	.0014	.5029
R24495	24495	5317	3.2740	3.2778	.0038	2.2718	2.2701	.0017	.5029
R245	245	110AN	3.2485	3.2546	.0061	2.2525	2.2441	.0084	.5035
R24514	24514	24514	3.2739	3.2773	.0034	2.2717	2.2695	.0022	.5029
R24533	24533	24533	3.2740	3.2772	.0032	2.2720	2.2695	.0025	.5029
R2456	2456	5859	3.2638	3.2688	.0050	2.2636	2.2586	.0050	.5035
R24575	R24575	24575	0.0000	0.0000	0.0000	2.2778	2.2731	.0047	.5035
R24594	24594	24594	3.2798	3.2841	.0043	2.2785	2.2763	.0022	.5029
R245AO	245AO	245AO	3.2627	3.2710	.0083	2.2684	2.2586	.0098	.5045
R245R	245R	1106	3.2585	3.2643	.0058	2.2636	2.2539	.0097	.5035
R24606	24606	24606	3.2795	3.2828	.0033	2.2778	2.2748	.0030	.5029
R2467	2467	2467	3.2733	3.2766	.0033	2.2717	2.2691	.0026	.5029
R24676	R24676	24676	0.0000	0.0000	0.0000	2.2720	2.2663	.0057	.5035
R24689	R24689	24689	0.0000	0.0000	0.0000	2.2781	2.2739	.0042	.5035
R2468AS	2468AS	532AC	3.2600	3.2643	.0043	2.2528	2.2520	.0008	.5043
R24690	24690	24690	3.2795	3.2830	.0034	2.2775	2.2753	.0022	.5029
R24761	24761	24761	3.2796	3.2832	.0036	2.2787	2.2753	.0034	.5029
R24830	R24830	24830	0.0000	0.0000	0.0000	2.2725	2.2662	.0063	.5035
R24834	R24834	24834	0.0000	0.0000	0.0000	2.2713	2.2666	.0047	.5035
R24881	24881	24881	3.2743	3.2779	.0036	2.2722	2.2704	.0018	.5029
R24953	24953	24953	3.2743	3.2785	.0040	2.2725	2.2708	.0017	.5029
R24969	24969	24969	3.2745	3.2783	.0038	2.2718	2.2705	.0013	.5029
R2497	2497	6161AS	3.2584	3.2620	.0036	2.2562	2.2495	.0067	.5045

Bearing Assembly	Outer race s/n	Inner race s/n	O/R dia.	O/R restored dia.	O/R stock removed	I/R dia.	I/R restored dia.	I/R stock removed	New ball dia.
R2497	R2497	2497	0.0000	0.0000	0.0000	2.2520	2.2496	.0024	.5005
R25437	R25437	25437	0.0000	0.0000	0.0000	2.2690	2.2565	.0125	.5035
R2558	R2558	2558	0.0000	0.0000	0.0000	2.2511	2.2445	.0066	.5029
R259AS	259AS	2456	3.2585	3.2664	.0079	2.2602	2.2560	.0042	.5035
R259AS	R259AS	259AS	0.0000	0.0000	0.0000	2.2526	2.2443	.0083	.5029
R260Q	260Q	265AR	3.2590	3.2639	.0049	2.2543	2.2534	.0009	.5035
R260Q	R260Q	260Q	0.0000	0.0000	0.0000	2.2545	2.2474	.0071	.5029
R2611	2611	312AC	3.2535	3.2582	.0047	2.2478	2.2458	.0020	.5045
R2611	R2611	2611	0.0000	0.0000	0.0000	2.2485	2.2446	.0039	.5029
R2624	2624	2624	3.2598	3.2653	.0055	2.2528	2.2524	.0004	.5043
R2624	2624	2624	3.2734	3.2769	.0035	2.2705	2.2693	.0012	.5029
R2641AS	R2641AS	2641AS	0.0000	0.0000	0.0000	2.2538	2.2442	.0096	.5029
R264AR	264AR	173D	3.2580	3.2640	.0060	2.2533	2.2517	.0016	.5043
R2676	R2676	2676	0.0000	0.0000	0.0000	2.2528	2.2441	.0087	.5005
R2686	2686	8593AS	3.2530	3.2595	.0065	2.2516	2.2491	.0025	.5035
R268AE	268AE	673AM	3.2632	3.2645	.0013	2.2545	2.2527	.0018	.5040
R268AK	268AK	817AL	3.2580	3.2630	.0050	2.2544	2.2507	.0037	.5040
R2691	2691	2691	3.2736	3.2774	.0038	2.2717	2.2693	.0024	.5029
R2696	R2696	2696	0.0000	0.0000	0.0000	2.2545	2.2505	.0040	.5029
R270	270	270	3.2731	3.2761	.0030	2.2708	2.2656	.0052	.5040
R2704	2704	2704	3.2788	3.2839	.0051	2.2767	2.2732	.0035	.5040
R2729AS	2729AS	890AN	3.2593	3.2646	.0053	2.2626	2.2550	.0076	.5029
R2729AS	R2729AS	2729AS	0.0000	0.0000	0.0000	2.2537	2.2512	.0025	.5029
R2731	2731	834A	3.2580	3.2627	.0047	2.2516	2.2501	.0015	.5040
R2761	2761	2761	3.2724	3.2774	.0050	2.2700	2.2680	.0020	.5035
R2782AS	R2782AS	2782AS	0.0000	0.0000	0.0000	2.2544	2.2445	.0099	.5029
R2793	R2793	2793	0.0000	0.0000	0.0000	2.2543	2.2437	.0106	.5005
R2802	2802	2802	3.2733	3.2768	.0035	2.2705	2.2690	.0015	.5029
R2835	2835	2835	3.2738	3.2800	.0062	2.2704	2.2694	.0010	.5040
R2878	2878	2878	3.2739	3.2775	.0036	2.2715	2.2700	.0015	.5029
R2884	2884	394AE	3.2583	3.2656	.0073	2.2596	2.2553	.0043	.5035
R288P	R288P	288P	0.0000	0.0000	0.0000	2.2535	2.2473	.0062	.5029
R289AN	289AN	193V	3.2452	3.2523	.0071	2.2531	2.2413	.0118	.5035
R289AN	R289AN	289AN	0.0000	0.0000	0.0000	2.2416	2.2403	.0013	.5029
R2906	2906	2906	3.2737	3.2775	.0038	2.2709	2.2697	.0012	.5029
R294S	R294S	294S	0.0000	0.0000	0.0000	2.2536	2.2485	.0051	.5005
R2970	2970	2970	3.2724	3.2753	.0029	2.2688	2.2666	.0022	.5035
R2978	R2978	2978	0.0000	0.0000	0.0000	2.2715	2.2662	.0053	.5035
R298AN	298AN	5997	3.2448	3.2511	.0063	2.2429	2.2400	.0029	.5035
R298AN	R298AN	298AN	0.0000	0.0000	0.0000	2.2394	2.2390	.0004	.5005
R3029	3029	3029	3.2743	3.2781	.0038	2.2714	2.2704	.0010	.5029
R3036	3036	3036	3.2730	3.2765	.0035	2.2708	2.2691	.0017	.5029
R303AD	303AD	544AH	3.2575	3.2639	.0064	2.2542	2.2534	.0008	.5035
R303AD	R303AD	303AD	0.0000	0.0000	0.0000	2.2502	2.2470	.0032	.5029
R3075	3075	5767AS	3.2450	3.2505	.0055	2.2420	2.2410	.0010	.5029
R3075	R3075	3075	0.0000	0.0000	0.0000	2.2408	2.2372	.0036	.5029
R3090	3090	3090	3.2740	3.2780	.0040	2.2714	2.2704	.0010	.5029
R3100AS	R3100AS	3100AS	0.0000	0.0000	0.0000	2.2542	2.2435	.0107	.5005
R3112	3112	257AR	3.2450	3.2497	.0047	2.2550	2.2389	.0161	.5035
R3112	R3112	3112	0.0000	0.0000	0.0000	2.2407	2.2385	.0022	.5029
R315AO	R315AO	315AO	0.0000	0.0000	0.0000	2.2641	2.2503	.0138	.5029
R317AN	317AN	4638	3.2450	3.2530	.0080	2.2460	2.2423	.0037	.5035

Bearing Assembly	Outer race s/n	Inner race s/n	O/R dia.	O/R restored dia.	O/R stock removed	I/R dia.	I/R restored dia.	I/R stock removed	New ball dia.
R317AN	R317AN	317AN	0.0000	0.0000	0.0000	2.2402	2.2370	.0032	.5029
R318AG	318AG	5208	3.2455	3.2522	.0067	2.2426	2.2410	.0016	.5035
R318AG	R318AG	318AG	0.0000	0.0000	0.0000	2.2395	2.2375	.0020	.5029
R3205	3205	688AN	3.2584	3.2665	.0081	2.2575	2.2564	.0011	.5035
R322F	322F	3519AS	3.2590	3.2641	.0051	2.2550	2.2517	.0033	.5043
R322F	R322F	322F	0.0000	0.0000	0.0000	2.2537	2.2504	.0033	.5029
R3269AS	3269AS	2468AS	3.2590	3.2651	.0061	2.2535	2.2525	.0010	.5043
R331AM	331AM	4379	3.2578	3.2641	.0063	2.2543	2.2515	.0028	.5043
R331AM	R331AM	331AM	0.0000	0.0000	0.0000	2.2534	2.2492	.0042	.5029
R3357	3357	23243	3.2736	3.2775	.0039	2.2705	2.2668	.0037	.5040
R3382	3382	582AF	3.2580	3.2622	.0042	2.2530	2.2500	.0030	.5045
R3382	R3382	3382	0.0000	0.0000	0.0000	2.2543	2.2503	.0040	.5029
R3383	R3383	3383	0.0000	0.0000	0.0000	2.2517	2.2509	.0008	.5029
R342AN	342AN	751T	3.2450	3.2595	.0145	2.2523	2.2490	.0033	.5029
R3431	R3431	3431	0.0000	0.0000	0.0000	2.2545	2.2440	.0105	.5029
R343AM	343AM	2168AS	3.2580	3.2628	.0048	2.2626	2.2527	.0099	.5035
R343AM	R343AM	343AM	0.0000	0.0000	0.0000	2.2540	2.2444	.0096	.5029
R343X	343X	290AG	3.2583	3.2630	.0047	2.2547	2.2501	.0046	.5043
R3462AS	R3462AS	3462AS	0.0000	0.0000	0.0000	2.2548	2.2431	.0117	.5005
R3475	3475	2423	3.2580	3.2657	.0077	2.2590	2.2556	.0034	.5035
R3585	3585	7753AS	3.2574	3.2639	.0065	2.2550	2.2513	.0037	.5043
R3585	R3585	3585	0.0000	0.0000	0.0000	2.2538	2.2488	.0050	.5029
R3593AS	3593AS	3407	3.2590	3.2647	.0057	2.2546	2.2525	.0021	.5045
R3616	3616	1646	3.2723	3.2761	.0038	2.2693	2.2656	.0037	.5040
R365AD	365AD	20039	3.2548	3.2577	.0029	2.2530	2.2473	.0057	.5035
R3666	R3666	3666	0.0000	0.0000	0.0000	2.2693	2.2628	.0065	.5035
R370	R370	370	0.0000	0.0000	0.0000	2.2539	2.2427	.0112	.5029
R375AD	375AD	375AD	3.2580	3.2625	.0045	2.2520	2.2497	.0023	.5043
R375AF	375AF	S07521	3.2530	3.2686	.0156	2.2606	2.2596	.0010	.5029
R375AF	R375AF	375AF	0.0000	0.0000	0.0000	2.2485	2.2447	.0038	.5029
R3779	3779	3779	3.2734	3.2768	.0034	2.2703	2.2693	.0010	.5029
R3781AS	3781AS	1370AS	3.2586	3.2622	.0036	2.2546	2.2520	.0026	.5035
R3781AS	R3781AS	3781AS	0.0000	0.0000	0.0000	2.2528	2.2464	.0064	.5029
R3791	3791	3791	3.2735	3.2783	.0048	2.2719	2.2708	.0011	.5029
R380AD	R380AD	380AD	0.0000	0.0000	0.0000	2.2543	2.2497	.0046	.5029
R3835	R3835	3835	0.0000	0.0000	0.0000	2.2548	2.2396	.0152	.5029
R3867AS	R3867AS	3867AS	0.0000	0.0000	0.0000	2.2534	2.2476	.0058	.5029
R3917	3917	4439	3.2719	3.2754	.0035	2.2700	2.2676	.0024	.5029
R3917	R3917	3917	0.0000	0.0000	0.0000	2.2700	2.2672	.0028	.5035
R3938AS	3938AS	433AP	3.2595	3.2660	.0065	2.2578	2.2540	.0038	.5045
R3938AS	R3938AS	3938AS	0.0000	0.0000	0.0000	2.2535	2.2474	.0061	.5029
R3959AS	3959AS	3269AS	3.2588	3.2644	.0056	2.2543	2.2522	.0021	.5045
R396AR	396AR	300G	3.2580	3.2650	.0070	2.2582	2.2548	.0034	.5035
R4019	R4019	4019	0.0000	0.0000	0.0000	2.2634	2.2507	.0127	.5005
R4054	4054	4191AS	3.2590	3.2643	.0053	2.2530	2.2520	.0010	.5040
R4054	R4054	4054	0.0000	0.0000	0.0000	2.2547	2.2503	.0044	.5029
R4105	R4105	4105	0.0000	0.0000	0.0000	2.2550	2.2479	.0071	.5029
R4124	4124	5325AS	3.2585	3.2629	.0044	2.2520	2.2509	.0011	.5040
R4132	4132	195AS	3.2575	3.2626	.0051	2.2530	2.2524	.0060	.5029
R4135	4135	2318	3.2720	3.2778	.0058	2.2725	2.2700	.0025	.5029
R4143AS	4143AS	9026AS	3.2500	3.2565	.0065	2.2533	2.2447	.0086	.5035
R4143AS	R4143AS	4143AS	0.0000	0.0000	0.0000	2.2460	2.2432	.0028	.5029

Bearing Assembly	Outer race s/n	Inner race s/n	O/R dia.	O/R restored dia.	O/R stock removed	I/R dia.	I/R restored dia.	I/R stock removed	New ball dia.
R4150	R4150	4150	0.0000	0.0000	0.0000	2.2546	2.2430	.0116	.5029
R4186	R4186	4186	0.0000	0.0000	0.0000	2.2543	2.2507	.0036	.5029
R418AT	R418AT	418AT	0.0000	0.0000	0.0000	2.2522	2.2460	.0062	.5029
R4191AS	4191AS	218Z	3.2584	3.2652	.0068	2.2542	2.2531	.0011	.5045
R4248	R4248	4248	0.0000	0.0000	0.0000	2.2698	2.2659	.0039	.5035
R426AN	R426AN	426AN	0.0000	0.0000	0.0000	2.2475	2.2448	.0027	.5029
R428AB	R428AB	428AB	0.0000	0.0000	0.0000	2.2525	2.2462	.0063	.5005
R4316AS	R4316AS	4316AS	0.0000	0.0000	0.0000	2.2533	2.2499	.0034	.5005
R437AM	437AM	1367AS	3.2580	3.2620	.0040	2.2546	2.2516	.0030	.5035
R4430AS	4430AS	710AK	3.2586	3.2639	.0053	2.2580	2.2534	.0046	.5035
R4439	4439	4094	3.2729	3.2761	.0032	2.2702	2.2673	.0029	.5035
R4463	R4463	4463	0.0000	0.0000	0.0000	2.2715	2.2671	.0044	.5035
R450AK	R450AK	450AK	0.0000	0.0000	0.0000	2.2542	2.2503	.0039	.5029
R4555	4555	20739	3.2738	3.2770	.0032	2.2709	2.2692	.0017	.5029
R455AL	R455AL	455AL	0.0000	0.0000	0.0000	2.2540	2.2471	.0069	.5029
R4591	R4591	4591	0.0000	0.0000	0.0000	2.2542	2.2474	.0070	.5029
R459AO	R459AO	459AO	0.0000	0.0000	0.0000	2.2482	2.2443	.0039	.5029
R460AJ	R460AJ	460AJ	0.0000	0.0000	0.0000	2.2535	2.2480	.0055	.5029
R4638	4638	738AP	3.2515	3.2564	.0049	2.2483	2.2448	.0035	.5040
R4694AS	4694AS	1084	3.2589	3.2638	.0049	2.2543	2.2531	.0012	.5035
R4694AS	R4694AS	4694AS	0.0000	0.0000	0.0000	2.2535	2.2506	.0029	.5029
R471AF	R471AF	471AF	0.0000	0.0000	0.0000	2.2620	2.2470	.0150	.5005
R4733	R4733	4733	0.0000	0.0000	0.0000	2.2532	2.2445	.0087	.5029
R4744	4744	5816	3.2580	3.2650	.0070	2.2570	2.2546	.0024	.5035
R4744	R4744	4744	0.0000	0.0000	0.0000	2.2537	2.2505	.0032	.5029
R477AJ	R477AJ	477AJ	0.0000	0.0000	0.0000	2.2535	2.2476	.0059	.5029
R477C	R477C	477C	0.0000	0.0000	0.0000	2.2526	2.2487	.0039	.5029
R4826AS	4826AS	116AA	3.2586	3.2639	.0053	2.2566	2.2546	.0020	.5029
R4845	R4845	4845	0.0000	0.0000	0.0000	2.2480	2.2443	.0037	.5029
R507511	R507511	507511	0.0000	0.0000	0.0000	2.2520	2.2502	.0018	.5005
R5186	R5186	5186	0.0000	0.0000	0.0000	2.2513	2.2472	.0041	.5029
R5229	5229	707	3.2522	3.2563	.0041	2.2489	2.2436	.0053	.5040
R523L	523L	8067AS	3.2578	3.2637	.0059	2.2520	2.2517	.0003	.5043
R525AD	R525AD	525AD	0.0000	0.0000	0.0000	2.2543	2.2477	.0066	.5029
R527AK	R527AK	527AK	0.0000	0.0000	0.0000	2.2527	2.2452	.0075	.5029
R529V	R529V	529V	0.0000	0.0000	0.0000	2.2587	2.2440	.0147	.5029
R5304	5304	588AR	3.2635	3.2679	.0044	2.2650	2.2588	.0062	.5029
R5325AS	5325AS	841V	3.2580	3.2640	.0060	2.2622	2.2548	.0074	.5029
R532AC	532AC	782AE	3.2543	3.2639	.0046	2.2545	2.2512	.0033	.5043
R534AP	R534AP	534AP	0.0000	0.0000	0.0000	2.2547	2.2472	.0075	.5029
R540AG	R540AG	540AG	0.0000	0.0000	0.0000	2.2547	2.2441	.0106	.5029
R5411AS	5411AS	396AR	3.2579	3.2632	.0053	2.2551	2.2540	.0011	.5029
R5411AS	R5411AS	5411AS	0.0000	0.0000	0.0000	2.2532	2.2483	.0049	.5029
R543AE	543AE	1063	3.2580	3.2611	.0051	2.2539	2.2520	.0019	.5029
R543AE	R543AE	543AE	0.0000	0.0000	0.0000	2.2537	2.2433	.0104	.5029
R543AH	R543AH	543AH	0.0000	0.0000	0.0000	2.2535	2.2482	.0053	.5029
R544AH	544AH	928AJ	3.2578	3.2644	.0066	2.2538	2.2520	.0018	.5040
R545AF	R545AF	545AF	0.0000	0.0000	0.0000	2.2450	2.2400	.0050	.5029
R547AH	547AH	491AF	3.2584	3.2650	.0066	2.2580	2.2523	.0047	.5040
R5484	5484	3432	3.2600	3.2646	.0046	2.2540	2.2527	.0013	.5043
R550AH	R550AH	550AH	0.0000	0.0000	0.0000	2.2535	2.2470	.0065	.5005
R555AJ	555AJ	2552	3.2576	3.2631	.0055	2.2520	2.2508	.0012	.5043

Bearing Assembly	Outer race s/n	Inner race s/n	O/R dia.	O/R restored dia.	O/R stock removed	I/R dia.	I/R restored dia.	I/R stock removed	New ball dia.
R558AJ	558AJ	3205	3.2582	3.2640	.0058	2.2547	2.2523	.0024	.5043
R5597AS	5597AS	205AC	3.2475	3.2531	.0056	2.2528	2.2422	.0106	.5035
R5597AS	R5597AS	5597AS	0.0000	0.0000	0.0000	2.2430	2.2359	.0071	.5029
R5599AS	5599AS	827AJ	3.2487	3.2639	.0152	2.2543	2.2533	.0010	.5035
R5599AS	R5599AS	5599AS	0.0000	0.0000	0.0000	2.2519	2.2395	.0124	.5029
R567AA	567AA	567AA	3.2575	3.2605	.0030	2.2512	2.2499	.0013	.5035
R569AP	569AP	5484	3.2568	3.2633	.0065	2.2540	2.2527	.0013	.5035
R569AP	R569AP	569AP	0.0000	0.0000	0.0000	2.2520	2.2498	.0022	.5029
R5816	5816	314AO	3.2627	3.2681	.0054	2.2589	2.2576	.0013	.5035
R582AF	582AF	3770	3.2577	3.2623	.0046	2.2530	2.2507	.0023	.5040
R5851	5851	3959AS	3.2630	3.2663	.0033	2.2553	2.2543	.0010	.5045
R5851	R5851	5851	0.0000	0.0000	0.0000	2.2636	2.2494	.0142	.5029
R5916	5916	6916	3.2490	3.2534	.0044	2.2443	2.2410	.0033	.5043
R5923	5923	5923	3.2487	3.2514	.0027	2.2435	2.2409	.0026	.5035
R5944	5944	606AO	3.2580	3.2611	.0031	2.2528	2.2520	.0008	.5029
R5944	R5944	5944	0.0000	0.0000	0.0000	2.2510	2.2439	.0071	.5005
R602AP	R602AP	602AP	0.0000	0.0000	0.0000	2.2539	2.2442	.0097	.5029
R604W	R604W	604W	0.0000	0.0000	0.0000	2.2520	2.2470	.0005	.5029
R606AO	606AO	865AG	3.2578	3.2639	.0061	2.2552	2.2520	.0032	.5043
R606AS	606AS	268AE	3.2573	3.2654	.0081	2.2621	2.2553	.0068	.5035
R606AS	R606AS	606AS	0.0000	0.0000	0.0000	2.2533	2.2486	.0065	.5029
R6077	6077	2028AS	3.2425	3.2477	.0052	2.2410	2.2365	.0045	.5035
R6077	R6077	6077	0.0000	0.0000	0.0000	2.2375	2.2360	.0015	.5005
R6081	6081	6081	3.2729	3.2760	.0031	2.2708	2.2685	.0022	.5029
R6126AS	R6126AS	6126AS	0.0000	0.0000	0.0000	2.2542	2.2515	.0027	.5029
R638AO	R638AO	638AO	0.0000	0.0000	0.0000	2.2536	2.2478	.0058	.5029
R647A	647A	3905AS	3.2585	3.2637	.0052	2.2545	2.2517	.0028	.5045
R647A	R647A	467A	0.0000	0.0000	0.0000	2.2531	2.2505	.0029	.5005
R649AO	649AO	5892	3.2580	3.2654	.0074	2.2579	2.2558	.0021	.5029
R649AO	R649AO	649AO	0.0000	0.0000	0.0000	2.2543	2.2477	.0066	.5029
R650AA	R650AA	650AA	0.0000	0.0000	0.0000	2.2505	2.2438	.0067	.5029
R656AG	R656AG	656AG	0.0000	0.0000	0.0000	2.2451	2.2433	.0018	.5005
R666AP	666AP	145Y	3.2535	3.2561	.0026	2.2534	2.2457	.0077	.5029
R666AP	R666AP	666AP	0.0000	0.0000	0.0000	2.2484	2.2377	.0107	.5005
R667AG	667AG	SO3601	3.2580	3.2647	.0067	2.2575	2.2543	.0032	.5035
R668Q	R668Q	668Q	0.0000	0.0000	0.0000	2.2520	2.2498	.0022	.5005
R670AK	R670AK	670AK	0.0000	0.0000	0.0000	2.2533	2.2492	.0041	.5005
R6723	6723	6723	3.2741	3.2773	.0032	2.2722	2.2694	.0026	.5029
R673AM	673AM	3307	3.2575	3.2637	.0062	2.2544	2.2515	.0029	.5045
R6827	6827	6827	3.2721	3.2749	.0028	2.2700	2.2662	.0038	.5035
R683G	R683G	683G	0.0000	0.0000	0.0000	2.2530	2.2442	.0088	.5029
R6870	6870	6870	3.2730	3.2771	.0041	2.2701	2.2681	.0020	.5035
R688AN	688AN	5309	3.2624	3.2691	.0067	2.2604	2.2590	.0014	.5035
R688L	688L	717AA	3.2580	3.2637	.0057	2.2532	2.2514	.0018	.5043
R688L	R688L	688L	0.0000	0.0000	0.0000	2.2532	2.2501	.0031	.5029
R6910	6910	6910	3.2732	3.2767	.0035	2.2702	2.2663	.0039	.5040
R692AO	692AO	381AJ	3.2575	3.2677	.0102	2.2580	2.2576	.0004	.5035
R692AO	R692AO	692AO	0.0000	0.0000	0.0000	2.2533	2.2513	.0020	.5029
R697	697	235T	3.2563	3.2605	.0042	2.2516	2.2480	.0036	.5040
R697	R697	697	0.0000	0.0000	0.0000	2.2521	2.2448	.0073	.5029
R697AR	R697AR	697AR	0.0000	0.0000	0.0000	2.2539	2.2444	.0095	.5029
R697I	697I	1952	3.2619	3.2665	.0046	2.2585	2.2558	.0027	.5035

Bearing Assembly	Outer race s/n	Inner race s/n	O/R dia.	O/R restored dia.	O/R stock removed	I/R dia.	I/R restored dia.	I/R stock removed	New ball dia.
R697I	R697I	6971	0.0000	0.0000	0.0000	2.2565	2.2488	.0077	.5029
R701AO	R701AO	701AO	0.0000	0.0000	0.0000	2.2538	2.2472	.0066	.5005
R702Q	702Q	672AG	3.2580	3.2636	.0056	2.2547	2.2509	.0038	.5045
R702Q	R702Q	702Q	0.0000	0.0000	0.0000	2.2534	2.2501	.0033	.5029
R709AD	709AD	173AF	3.2575	3.2633	.0058	2.2567	2.2526	.0041	.5035
R713	713	713	3.2736	3.2771	.0035	2.2721	2.2697	.0024	.5029
R717AA	717AA	7775AS	3.2685	3.2627	.0042	2.2550	2.2511	.0039	.5043
R726U	726U	1637	3.2587	3.2647	.0060	2.2537	2.2517	.0020	.5043
R726U	R726U	726U	0.0000	0.0000	0.0000	2.2531	2.2515	.0016	.5029
R732L	R732L	732L	0.0000	0.0000	0.0000	2.2519	2.2496	.0023	.5029
R738AP	738AP	7784AS	3.2580	3.2635	.0055	2.2547	2.2533	.0014	.5035
R741AF	R741AF	741AF	0.0000	0.0000	0.0000	2.2544	2.2501	.0043	.5029
R760G	760G	658M	3.2584	3.2635	.0051	2.2538	2.2508	.0030	.5043
R760G	R760G	760G	0.0000	0.0000	0.0000	2.2520	2.2497	.0023	.5005
R7653AS	R7653AS	7653AS	0.0000	0.0000	0.0000	2.2507	2.2496	.0011	.5029
R7784AS	7784AS	547AH	3.2592	3.2638	.0046	2.2549	2.2533	.0016	.5035
R778P	778P	131AV	3.2580	3.2633	.0053	2.2537	2.2508	.0029	.5043
R778P	R778P	778P	0.0000	0.0000	0.0000	2.2536	2.2495	.0041	.5029
R785AJ	785AJ	854W	3.2594	3.2657	.0063	2.2580	2.2560	.0030	.5035
R785AJ	R785AJ	785AJ	0.0000	0.0000	0.0000	2.2553	2.2503	.0050	.5029
R785Y	785Y	3088AS	3.2583	3.2635	.0052	2.2535	2.2513	.0022	.5040
R785Y	R785Y	785Y	0.0000	0.0000	0.0000	2.2510	2.2440	.0070	.5029
R789AT	R789AT	789AT	0.0000	0.0000	0.0000	2.2543	2.2475	.0068	.5029
R794AH	R794AH	794AH	0.0000	0.0000	0.0000	2.2505	2.2483	.0022	.5005
R7957	7957	5837	3.2587	3.2657	.0070	2.2589	2.2550	.0039	.5035
R7957	R7957	7957	0.0000	0.0000	0.0000	2.2536	2.2494	.0042	.5029
R803G	803G	667AG	3.2580	3.2644	.0064	2.2535	2.2526	.0009	.5043
R805Z	805Z	712AJ	3.2491	3.2696	.0205	2.2647	2.2595	.0052	.5035
R817AL	817AL	378AJ	3.2586	3.2660	.0074	2.2604	2.2551	.0053	.5035
R822G	822G	5304	3.2587	3.2653	.0066	2.2595	2.2551	.0044	.5035
R822G	R822G	822G	0.0000	0.0000	0.0000	2.2529	2.2502	.0027	.5005
R822R	822R	4011	3.2570	3.2623	.0053	2.2535	2.2520	.0015	.5035
R827AJ	827AJ	1963AS	3.2576	3.2630	.0054	2.2553	2.2523	.0030	.5035
R829AC	R829AC	829AC	0.0000	0.0000	0.0000	2.2520	2.2443	.0077	.5029
R831AN	831AN	5410	3.2526	3.2584	.0058	2.2472	2.2458	.0014	.5043
R833AK	833AK	833AK	3.2575	3.2622	.0047	2.2538	2.2500	.0038	.5043
R834A	834A	S07541	3.2580	3.2682	.0102	2.2610	2.2582	.0028	.5035
R834AE	834AE	5651AS	3.2434	3.2500	.0066	2.2413	2.2395	.0018	.5035
R834AE	R834AE	834AE	0.0000	0.0000	0.0000	2.2390	2.2382	.0008	.5029
R835AN	835AN	805Z	3.2480	3.2534	.0054	2.2438	2.2410	.0028	.5043
R835AN	R835AN	835AN	0.0000	0.0000	0.0000	2.2434	2.3880	.0046	.5029
R844AM	844AM	228U	3.2580	3.2661	.0081	2.2586	2.2560	.0026	.5035
R844AM	R844AM	844AM	0.0000	0.0000	0.0000	2.2545	2.2511	.0034	.5005
R8593AS	8593AS	1083	3.2568	3.2619	.0051	2.2543	2.2518	.0025	.5035
R865AE	865AE	644M	3.2583	3.2651	.0068	2.2555	2.2550	.0005	.5035
R865AE	R865AE	865AE	0.0000	0.0000	0.0000	2.2528	2.2512	.0016	.5029
R879AJ	879AJ	191AF	3.2580	3.2629	.0049	2.2530	2.2500	.0030	.5045
R879AJ	R879AJ	879AJ	0.0000	0.0000	0.0000	2.2538	2.2499	.0039	.5005
R880D	R880D	880D	0.0000	0.0000	0.0000	2.2530	2.2500	.0030	.5029
R881AE	881AE	268AK	3.2580	3.2640	.0060	2.2530	2.2512	.0018	.5043
R881AE	R881AE	881AE	0.0000	0.0000	0.0000	2.2533	2.2504	.0029	.5029
R890AM	890AM	58ZZ	3.2580	3.2658	.0078	2.2589	2.2556	.0033	.5029

Bearing Assembly	Outer race s/n	Inner race s/n	O/R dia.	O/R restored dia.	O/R stock removed	I/R dia.	I/R restored dia.	I/R stock removed	New ball dia.
R892AF	R892AF	892AF	0.0000	0.0000	0.0000	2.2534	2.2502	.0032	.5029
R9114AS	R9114AS	9114AS	0.0000	0.0000	0.0000	2.2515	2.2445	.0070	.5029
R919AD	919AD	609F	3.2580	3.2624	.0044	2.2518	2.2501	.0017	.5045
R919AD	R919AD	919AD	0.0000	0.0000	0.0000	2.2527	2.2441	.0086	.5029
R923AP	923AP	6000	3.2451	3.2524	.0073	2.2441	2.2413	.0028	.5035
R923AP	R923AP	923AP	0.0000	0.0000	0.0000	2.2411	2.2392	.0019	.5029
R928AJ	928AJ	264AR	3.2573	3.2641	.0068	2.2543	2.2513	.0030	.5040
R931AP	931AP	931AP	3.2500	3.2027	.0027	2.2440	2.2405	.0035	.5043
R935AL	935AL	5153	3.2580	3.2670	.0090	2.2596	2.2563	.0033	.5035
R956AR	956AR	3508AS	3.2582	3.2647	.0065	2.2540	2.2520	.0020	.5043
R9584AS	R9584AS	9584AS	0.0000	0.0000	0.0000	2.2500	2.2438	.0062	.5005
R9638AS	R9638AS	9638AS	0.0000	0.0000	0.0000	2.2478	2.2457	.0021	.5005
R965AH	965AH	935AL	3.2440	3.2635	.0195	2.2550	2.2533	.0017	.5035
R965AH	R965AH	965AH	0.0000	0.0000	0.0000	2.2393	2.2361	.0032	.5005
R966AH	966AH	5229	3.2486	3.2535	.0049	2.2473	2.2433	.0040	.5035
R966AH	R966AH	966AH	0.0000	0.0000	0.0000	2.2442	2.2437	.0005	.5029
R984AH	R984AH	984AH	0.0000	0.0000	0.0000	2.2392	2.2362	.0030	.5029
R985R	985R	739AN	3.2582	3.2655	.0073	2.2595	2.2549	.0046	.5035
R985R	R985R	985R	0.0000	0.0000	0.0000	2.2519	2.2503	.0016	.5029
R9875	9875	5970	3.2485	3.2554	.0069	2.2516	2.2441	.0075	.5035
R9875	R9875	9875	0.0000	0.0000	0.0000	2.2530	2.2434	.0096	.5029
R987AP	987AP	890AM	3.2485	3.2538	.0053	2.2542	2.2437	.0104	.5035
R987AP	R987AP	987AP	0.0000	0.0000	0.0000	2.2442	2.2438	.0004	.5029
R988U	988U	988U	3.2627	3.2674	.0047	2.2566	2.2550	.0016	.5043
RS05591	S05591	4250AS	3.2580	3.2650	.0070	2.2602	2.2528	.0074	.5045
RS05601	RS05601	S05601	0.0000	0.0000	0.0000	2.2508	2.2496	.0012	.5029
RS05601	S05601	S05591	3.2734	3.2786	.0052	2.2706	2.2696	.0010	.5035
RS05991	RS05991	S05991	0.0000	0.0000	0.0000	2.2416	2.2376	.0040	.5005
RS07531	RS07531	S07531	0.0000	0.0000	0.0000	2.2509	2.2444	.0055	.5029

APPENDIX E

BEARING NUMBER CROSS-REFERENCE TABLES

TABLE I
Original Army Serial Numbers
Cross Referenced To SwRI Identification Number

SWRI ID	ARMY S/N	SWRI ID	ARMY S/N	SWRI ID	ARMY S/N
S02611	1114AS	S03041	257AR	S03471	785Y
S02621	114AF	S03051	2696	S03481	803G
S02631	115Q	S03061	2761	S03491	805Z
S02641	1271	S03071	2835	S03501	817AL
S02651	12730	S03081	288P	S03511	822G
S02661	127R	S03091	294S	S03521	834AE
S02671	1370AS	S03101	298AN	S03531	844AM
S02681	138R	S03111	315AO	S03541	865AG
S02691	14023	S03121	318AG	S03551	879AJ
S02701	144Q	S03131	3205	S03561	880D
S02711	145Y	S03141	322AD	S03571	9026AS
S02721	147AD	S03151	343AG	S03581	9584AS
S02731	150AS	S03161	343AM	S03591	988U
S02741	16030	S03171	375AF	S03601	9999
S02751	1631AS	S03181	3770	S03611	108AD
S02761	16914	S03191	3867AS	S03621	110AN
S02771	18250	S03201	3905AS	S03631	12338
S02781	1854	S03211	4143AS	S03641	131W
S02791	18908	S03221	449AG	S03651	146AE
S02801	1909	S03231	4555	S03661	1636
S02811	1914	S03241	471AF	S03671	1710
S02821	191AF	S03251	4733	S03681	1856AS
S02831	195AS	S03261	477C	S03691	192AR
S02841	1963AS	S03271	491AF	S03701	19416
S02851	2020	S03281	5309	S03711	1945
S02861	2028AS	S03291	5317	S03721	195Z
S02871	203Z	S03301	540AG	S03731	197E
S02881	20739	S03311	5410	S03741	205AC
S02891	21845	S03321	543AH	S03751	2085
S02901	23243	S03331	5484	S03761	218Y
S02911	2344AS	S03341	5597AS	S03771	2244
S02921	23582	S03351	5822	S03781	228U
S02931	2382AS	S03361	602AP	S03791	2325
S02941	24257	S03371	606AS	S03801	2358
S02951	2430AS	S03381	649AO	S03811	23792
S02961	24349	S03391	670AK	S03821	2391
S02971	24606	S03401	677AP	S03831	2456
S02981	24676	S03411	724AJ	S03841	245AO
S02991	24819	S03421	732L	S03851	245R
S03001	24834	S03431	738AP	S03861	259AS
S03011	2492AS	S03441	739AN	S03871	2611
S03021	24953	S03451	7775AS	S03881	2624
S03031	2555	S03461	778P	S03891	2686

SWRI ID	ARMY S/N	SWRI ID	ARMY S/N	SWRI ID	ARMY S/N
S03901	268AK	S04401	609F	S04901	268AE
S03911	2729AS	S04411	6126AS	S04911	270
S03921	2782AS	S04421	652L	S04921	2704
S03931	2793	S04431	656AG	S04931	2867
S03941	2938	S04441	666AP	S04941	2970
S03951	2978	S04451	667AG	S04951	3029
S03961	300G	S04461	688AN	S04961	3036
S03971	3054AS	S04471	694AS	S04971	3075
S03981	305AS	S04481	701AO	S04981	3100AS
S03991	3088AS	S04491	702Q	S04991	3112
S04001	317AN	S04501	734AN	S05001	3269AS
S04011	322F	S04511	741AP	S05011	3307
S04021	331AM	S04521	753AS	S05021	3382
S04031	338	S04531	760G	S05031	3432
S04041	3407	S04541	789AT	S05041	3585
S04051	3431	S04551	794AH	S05051	3593AS
S04061	343X	S04561	827AJ	S05061	365AD
S04071	3462AS	S04571	814V	S05071	3666
S04081	3519AS	S04581	890AM	S05081	370
S04091	2131AS	S04591	966AH	S05091	3731
S04101	378AJ	S04601	984AH	S05101	390X
S04111	3835	S04611	1063	S05111	3917
S04121	3938AS	S04621	1106	S05121	3959AS
S04131	4105	S04631	116AA	S05131	4011
S04141	4150	S04641	1285	S05141	4124
S04151	4250AS	S04651	13459	S05151	4132
S04161	426AN	S04661	1391	S05161	428AB
S04171	433AP	S04671	144AF	S05171	4316AS
S04181	4432AS	S04681	1646	S05181	4379
S04191	4537	S04691	1731	S05191	4430AS
S04201	455AL	S04701	17719	S05201	4450
S04211	4565	S04711	1814	S05211	450AK
S04221	4596AS	S04721	20039	S05221	460AJ
S04231	4638	S04731	205G	S05231	4826AS
S04241	4694AS	S04741	215AF	S05241	5208
S04251	477AJ	S04751	218AP	S05251	527AK
S04261	5229	S04761	2223	S05261	534AP
S04271	529V	S04771	22598	S05271	5368AS
S04281	537AO	S04781	230AL	S05281	5530
S04291	5411AS	S04791	23467	S05291	582AF
S04301	543AE	S04801	235T	S05301	589Z
S04311	544AH	S04811	238AD	S05311	5923
S04321	558AJ	S04821	2414	S05321	5944
S04331	5186	S04831	24495	S05331	604W
S04341	5816	S04841	24514	S05341	638AO
S04351	5837	S04851	24575	S05351	647A
S04361	5851	S04861	25437	S05361	668Q
S04371	588AR	S04871	2552	S05371	672AG
S04381	606AO	S04881	264AR	S05381	673AM
S04391	6077	S04891	265AR	S05391	688L

SWRI ID	ARMY S/N	SWRI ID	ARMY S/N	SWRI ID	ARMY S/N
S05401	692AO	S05901	2274	S06401	650AA
S05411	697AR	S05911	22774	S06411	683G
S05421	697I	S05921	23020	S06421	6870
S05431	712AJ	S05931	23317	S06431	6910
S05441	726U	S05941	23356	S06441	697
S05451	741AF	S05951	241AX	S06451	709AO
S05461	747AM	S05961	2434	S06461	713
S05471	751AG	S05971	243AC	S06471	751T
S05481	774AD	S05981	24409	S06481	7753AS
S05491	782AE	S05991	245	S06491	785AJ
S05501	822R	S06001	24533	S06501	829AC
S05511	833AK	S06011	24594	S06511	834A
S05521	835AN	S06021	245E	S06521	854W
S05531	881AE	S06031	24689	S06531	856AG
S05541	912X	S06041	24690	S06541	865AE
S05551	919AD	S06051	24881	S06551	892AF
S05561	928AJ	S06061	24969	S06561	923AP
S05571	931AP	S06071	2641AS	S06571	965AH
S05581	935AL	S06081	2691	S06581	985R
S05591	9999	S06091	2731	S06591	9875
S05601	9999	S06101	2802	S06601	987AP
S05611	1034AS	S06111	2878	S06611	1064
S05621	103AC	S06121	2906	S06621	1302AS
S05631	1077	S06131	290AG	S06641	131AV
S05641	1083	S06141	3357	S06651	14594
S05651	1084	S06151	375AD	S06661	14634
S05661	111T	S06161	3781AS	S06671	1478
S05671	113AL	S06171	380AD	S06681	1508
S05681	1161AS	S06181	381AJ	S06691	1549
S05691	125AD	S06191	3928	S06701	1646
S05701	1367AS	S06201	394AE	S06711	16546
S05711	1528	S06211	396AR	S06721	173D
S05721	15529	S06221	4019	S06731	1818
S05731	15780	S06231	4054	S06741	1821
S05741	159AH	S06241	4186	S06751	1856
S05751	16120	S06251	4439	S06761	18719
S05761	1637	S06261	459AO	S06771	1882
S05771	1649AS	S06271	5153	S06781	2168AS
S05781	173AF	S06281	525AD	S06791	22836
S05791	179X	S06291	532AC	S06801	2283AS
S05801	1822	S06301	545AF	S06811	2318
S05811	193V	S06311	555AJ	S06821	23636
S05821	2028	S06321	569AP	S06831	23638
S05831	2075	S06331	5737	S06841	2390AS
S05841	2182	S06341	5767AS	S06851	2393AS
S05851	22189	S06351	5859	S06861	2423
S05861	2226	S06361	5970	S06871	2467
S05871	22514	S06371	6081	S06881	2468AS
S05881	2254	S06381	6161AS	S06891	24709
S05891	22565	S06391	644M	S06901	24761

SWRI ID	ARMY S/N
S06911	24830
S06921	2497
S06931	25139
S06941	260Q
S06951	2624
S06961	2656
S06971	2676
S06981	2884
S06991	289AN
S07001	303AD
S07011	3090
S07021	312AC
S07031	3383
S07041	342AN
S07051	3475
S07061	3508AS
S07071	3779
S07081	3791
S07091	4094
S07101	4135
S07111	4191AS
S07121	4223
S07131	4228AS
S07141	4248
S07151	437AM
S07161	4433AS
S07171	4591
S07181	4744
S07191	4845
S07201	489AE
S07211	523L
S07221	5304
S07231	5325AS
S07241	547AH
S07251	550AH
S07261	5599AS
S07271	5651AS
S07281	567AA
S07291	5916
S07301	5997
S07311	6000
S07321	603AE
S07331	658M
S07341	661AD
S07351	668AB
S07361	6723
S07371	6827
S07381	710AK
S07391	717AA
S07401	7653AS
S07411	7784AS
S07421	7957
S07431	8067AS
S07441	831AN
S07451	841G
S07461	890AN
S07471	9114AS
S07481	956AR
S07491	958
S07501	9638AS
S07511	9999
S07521	9999
S07531	9999
S07541	9999
S07561	964AG
S07571	4463
S07581	2558
S07591	314A0
S07601	418AT
S07611	707
S07621	8593AS
S07671	445BA
S07701	712BC
S07711	J0682
S07721	J0683
S07731	J0695
S07741	J0698
S07751	J0705
S07761	J0711
S07771	J0718
S07781	J0729

SWRI ID	ARMY S/N

TABLE II
Original SwRI Identification Numbers Cross Referenced To Army Serial Numbers

ARMY S/N	SWRI ID	ARMY S/N	SWRI ID	ARMY S/N	SWRI ID
1034AS	S05611	1528	S05711	197E	S03731
103AC	S05621	1549	S06691	20039	S04721
1063	S04611	15529	S05721	2020	S02851
1064	S06611	15780	S05731	2028	S05821
1077	S05631	159AH	S05741	2028AS	S02861
1083	S05641	16030	S02741	203Z	S02871
1084	S05651	16120	S05751	205AC	S03741
108AD	S03611	1631AS	S02751	205G	S04731
1106	S04621	1636	S03661	20739	S02881
110AN	S03621	1637	S05761	2075	S05831
1114AS	S02611	1646	S04681	2085	S03751
111T	S05661	1646	S06701	2131AS	S04091
113AL	S05671	1649AS	S05771	215AF	S04741
114AF	S02621	16546	S06711	2168AS	S06781
115Q	S02631	16914	S02761	2182	S05841
1161AS	S05681	1710	S03671	21845	S02891
116AA	S04631	1731	S04691	218AP	S04751
12338	S03631	173AF	S05781	218Y	S03761
125AD	S05691	173D	S06721	22189	S05851
1271	S02641	17719	S04701	2223	S04761
12730	S02651	179X	S05791	2226	S05861
127R	S02661	1814	S04711	2244	S03771
1285	S04641	1818	S06731	22514	S05871
1302AS	S06621	1821	S06741	2254	S05881
131AV	S06641	1822	S05801	22565	S05891
131W	S03641	18250	S02771	22598	S04771
13459	S04651	1854	S02781	2274	S05901
1367AS	S05701	1856	S06751	22774	S05911
1370AS	S02671	1856AS	S03681	22836	S06791
138R	S02681	18719	S06761	2283AS	S06801
1391	S04661	1882	S06771	228U	S03781
14023	S02691	18908	S02791	23020	S05921
144AF	S04671	1909	S02801	230AL	S04781
144Q	S02701	1914	S02811	2318	S06811
14594	S06651	191AF	S02821	23243	S02901
145Y	S02711	192AR	S03691	2325	S03791
14634	S06661	193V	S05811	23317	S05931
146AE	S03651	19416	S03701	23356	S05941
1478	S06671	1945	S03711	2344AS	S02911
147AD	S02721	195AS	S02831	23467	S04791
1508	S06681	195Z	S03721	2358	S03801
150AS	S02731	1963AS	S02841	23582	S02921

ARMY S/N	SWRI ID
235T	S04801
23636	S06821
23638	S06831
23792	S03811
2382AS	S02931
238AD	S04811
2390AS	S06841
2391	S03821
2393AS	S06851
2414	S04821
241AX	S05951
2423	S06861
24257	S02941
2430AS	S02951
2434	S05961
24349	S02961
243AC	S05971
24409	S05981
24495	S04831
245	S05991
24514	S04841
24533	S06001
2456	S03831
24575	S04851
24594	S06011
245AO	S03841
245E	S06021
245R	S03851
24606	S02971
2467	S06871
24676	S02981
24689	S06031
2468AS	S06881
24690	S06041
24709	S06891
24761	S06901
24819	S02991
24830	S06911
24834	S03001
24881	S06051
2492AS	S03011
24953	S03021
24969	S06061
2497	S06921
25139	S06931
25437	S04861
2552	S04871
2555	S03031
2558	S07581
257AR	S03041
259AS	S03861
260Q	S06941
2611	S03871
2624	S03881
2624	S06951
2641AS	S06071
264AR	S04881
2656	S06961
265AR	S04891
2676	S06971
2686	S03891
268AE	S04901
268AK	S03901
2691	S06081
2696	S03051
270	S04911
2704	S04921
2729AS	S03911
2731	S06091
2761	S03061
2782AS	S03921
2793	S03931
2802	S06101
2835	S03071
2867	S04931
2878	S06111
2884	S06981
288P	S03081
289AN	S06991
2906	S06121
290AG	S06131
2938	S03941
294S	S03091
2970	S04941
2978	S03951
298AN	S03101
300G	S03961
3029	S04951
3036	S04961
303AD	S07001
3054AS	S03971
305AS	S03981
3075	S04971
3088AS	S03991
3090	S07011
3100AS	S04981
3112	S04991
312AC	S07021
314A0	S07591
315AO	S03111
317AN	S04001
318AG	S03121
3205	S03131
322AD	S03141
322F	S04011
3269AS	S05001
3307	S05011
331AM	S04021
3357	S06141
338	S04031
3382	S05021
3383	S07031
3407	S04041
342AN	S07041
3431	S04051
3432	S05031
343AG	S03151
343AM	S03161
343X	S04061
3462AS	S04071
3475	S07051
3508AS	S07061
3519AS	S04081
3585	S05041
3593AS	S05051
365AD	S05061
3666	S05071
370	S05081
3731	S05091
375AD	S06151
375AF	S03171
3770	S03181
3779	S07071
3781AS	S06161
378AJ	S04101
3791	S07081
380AD	S06171
381AJ	S06181
3835	S04111
3867AS	S03191
3905AS	S03201
390X	S05101
3917	S05111
3928	S06191
3938AS	S04121
394AE	S06201
3959AS	S05121
396AR	S06211
4011	S05131
4019	S06221

ARMY S/N	SWRI ID
4054	S06231
4094	S07091
4105	S04131
4124	S05141
4132	S05151
4135	S07101
4143AS	S03211
4150	S04141
4186	S06241
418AT	S07601
4191AS	S07111
4223	S07121
4228AS	S07131
4248	S07141
4250AS	S04151
426AN	S04161
428AB	S05161
4316AS	S05171
433AP	S04171
4379	S05181
437AM	S07151
4430AS	S05191
4432AS	S04181
4433AS	S07161
4439	S06251
4450	S05201
445BA	S07671
4463	S07571
449AG	S03221
450AK	S05211
4537	S04191
4555	S03231
455AL	S04201
4565	S04211
4591	S07171
4596AS	S04221
459AO	S06261
460AJ	S05221
4638	S04231
4694AS	S04241
471AF	S03241
4733	S03251
4744	S07181
477AJ	S04251
477C	S03261
4826AS	S05231
4845	S07191
489AE	S07201
491AF	S03271
5153	S06271
5186	S04331
5208	S05241
5229	S04261
523L	S07211
525AD	S06281
527AK	S05251
529V	S04271
5304	S07221
5309	S03281
5317	S03291
5325AS	S07231
532AC	S06291
534AP	S05261
5368AS	S05271
537AO	S04281
540AG	S03301
5410	S03311
5411AS	S04291
543AE	S04301
543AH	S03321
544AH	S04311
545AF	S06301
547AH	S07241
5484	S03331
550AH	S07251
5530	S05281
555AJ	S06311
558AJ	S04321
5597AS	S03341
5599AS	S07261
5651AS	S07271
567AA	S07281
569AP	S06321
5737	S06331
5767AS	S06341
5816	S04341
5822	S03351
582AF	S05291
5837	S04351
5851	S04361
5859	S06351
588AR	S04371
589Z	S05301
5916	S07291
5923	S05311
5944	S05321
5970	S06361
5997	S07301
6000	S07311
602AP	S03361
603AE	S07321
604W	S05331
606AO	S04381
606AS	S03371
6077	S04391
6081	S06371
609F	S04401
6126AS	S04411
6161AS	S06381
638AO	S05341
644M	S06391
647A	S05351
649AO	S03381
650AA	S06401
652L	S04421
656AG	S04431
658M	S07331
661AD	S07341
666AP	S04441
667AG	S04451
668AB	S07351
668Q	S05361
670AK	S03391
6723	S07361
672AG	S05371
673AM	S05381
677AP	S03401
6827	S07371
683G	S06411
6870	S06421
688AN	S04461
688L	S05391
6910	S06431
692AO	S05401
694AS	S04471
697	S06441
697AR	S05411
697I	S05421
701AO	S04481
702Q	S04491
707	S07611
709AO	S06451
710AK	S07381
712AJ	S05431
712BC	S07701
713	S06461
717AA	S07391
724AJ	S03411
726U	S05441
732L	S03421

ARMY S/N	SWRI ID
734AN	S04501
738AP	S03431
739AN	S03441
741AF	S05451
741AP	S04511
747AM	S05461
751AG	S05471
751T	S06471
753AS	S04521
760G	S04531
7653AS	S07401
774AD	S05481
7753AS	S06481
7775AS	S03451
7784AS	S07411
778P	S03461
782AE	S05491
785AJ	S06491
785Y	S03471
789AT	S04541
794AH	S04551
7957	S07421
803G	S03481
805Z	S03491
8067AS	S07431
814V	S04571
817AL	S03501
822G	S03511
822R	S05501
827AJ	S04561
829AC	S06501
831AN	S07441
833AK	S05511
834A	S06511
834AE	S03521
835AN	S05521
841G	S07451
844AM	S03531
854W	S06521
856AG	S06531
8593AS	S07621
865AE	S06541
865AG	S03541
879AJ	S03551
880D	S03561
881AE	S05531
890AM	S04581
890AN	S07461
892AF	S06551
9026AS	S03571
9114AS	S07471
912X	S05541
919AD	S05551
923AP	S06561
928AJ	S05561
931AP	S05571
935AL	S05581
956AR	S07481
958	S07491
9584AS	S03581
9638AS	S07501
964AG	S07561
965AH	S06571
966AH	S04591
984AH	S04601
985R	S06581
9875	S06591
987AP	S06601
988U	S03591
9999	S03601
9999	S05591
9999	S05601
9999	S07511
9999	S07521
9999	S07531
9999	S07541
J0682	S07711
J0683	S07721
J0696	S07731
J0698	S07741
J0705	S07751
J0711	S07761
J0718	S07771
J0729	S07781

ARMY S/N	SWRI ID

TABLE III
Inner and Outer Race Serial Numbers Cross Referenced To Refurbished Bearing Assembly Serial Numbers

New outer races manufactured by ITI are identified by an "R" prefix in the outer race serial numbers.

REFURB. BEARING ASSEMBLY	OUTER RACE S/N	INNER RACE S/N
R1034AS	R1034AS	1034AS
R1064	R1064	1064
R1077	1077	3054AS
R1077	R1077	1077
R1084	1084	338
R108AD	108AD	449AG
R108AD	R108AD	108AD
R110AN	110AN	4228AS
R1114AS	1114AS	2434
R111T	111T	1114AS
R111T	R111T	111T
R113AL	R113AL	113AL
R115Q	R115Q	115Q
R1161AS	R1161AS	1161AS
R12338	12338	16914
R125AD	R125AD	125AD
R1271	R1271	1271
R12730	12730	12730
R1302AS	1302AS	558AJ
R1302AS	R1302AS	1302AS
R13140	13140	4135
R13459	13459	13459
R1370AS	1370AS	694AS
R138R	R138R	138R
R1391	1391	103AC
R1391	R1391	1391
R14023	14023	24495
R14023	R14023	14023
R144AF	144AF	144AF
R144Q	R144Q	144Q
R14594	14594	22774
R14594	R14594	14594
R145Y	145Y	4124
R14634	14634	14634
R146AE	R146AE	146AE
R1478	R1478	1478
R147AD	R147AD	147AD
R1508	1508	523L
R1508	R1508	1508
R1549	1549	958
R1549	R1549	1549
R15529	15529	15529
R15780	15780	15780
R159AH	159AH	2884
R16030	16030	16030
R16120	16120	16120
R1636	1636	3593AS
R1636	R1636	1636
R1649AS	R1649AS	1649AS
R16546	16546	16546
R16914	16914	3357
R1710	R1710	1710
R1731	R1731	1731
R17719	17719	2867
R179X	179X	192AR
R179X	R179X	179X
R1814	1814	1822
R1821	R1821	1821
R18250	18250	18250
R1854	R1854	1854
R1856	1856	1856
R1856AS	1856AS	4132
R1856AS	R1856AS	1856AS
R18719	18719	18719
R1882	1882	1882
R18908	18908	18908
R1909	1909	1909
R1914	1914	1914
R19416	19416	19416
R1945	R1945	1945
R195AS	195AS	489AE
R1963AS	1963AS	131W
R197E	197E	305AS
R197E	R197E	197E
R20039	20039	2430AS
R2020	2020	2283AS
R2028	2028	2028
R2028AS	2028AS	322AD
R203Z	R203Z	203Z
R205AC	205AC	159AH
R205G	R205G	205G
R2075	R2075	2075
R2085	2085	709AO
R2085	R2085	2085

REFURB. BEARING ASSEMBLY	OUTER RACE S/N	INNER RACE S/N
R2131AS	2131AS	5368AS
R2131AS	R2131AS	2131AS
R215AF	215AF	753AS
R215AF	R215AF	215AF
R2168AS	2168AS	734AN
R2182	2182	4430AS
R21845	21845	21845
R218AP	R218AP	218AP
R218Y	218Y	437AM
R218Y	R218Y	218Y
R22189	R22189	22189
R2223	2223	22565
R2223	R2223	2223
R2226	2226	2226
R2244	2244	912X
R2244	R2244	2244
R22514	22514	22514
R2254	2254	3731
R2254	R2254	2254
R22598	22598	22598
R2274	2274	2274
R22774	22774	1814
R22836	22836	22836
R230AL	R230AL	230AL
R2318	2318	23638
R23243	23243	5737
R2325	2325	2325
R23317	23317	23317
R23356	R23356	23356
R2344AS	R2344AS	2344AS
R23467	23467	23467
R2358	R2358	2358
R23582	23582	23582
R235T	235T	856AG
R23636	R23636	23636
R23792	23792	23792
R2382AS	2382AS	803G
R2382AS	R2382AS	2382AS
R238AO	R238AO	238AO
R2390AS	R2390AS	2390AS
R2391	2391	2391
R2393AS	2393AS	2393AS
R2414	R2414	2414
R241AX	R241AX	241AX
R24257	24257	24257
R2430AS	2430AS	2731
R24349	24349	24349
R243AC	R243AC	243AC
R24409	24409	24409
R24495	24495	5317

REFURB. BEARING ASSEMBLY	OUTER RACE S/N	INNER RACE S/N
R245	245	110AN
R24514	24514	24514
R24533	24533	24533
R2456	2456	5859
R24575	R24575	24575
R24594	24594	24594
R245AO	245AO	245AO
R245R	245R	1106
R24606	24606	24606
R2467	2467	2467
R24676	R24676	24676
R24689	R24689	24689
R2468AS	2468AS	532AC
R24690	24690	24690
R24761	24761	24761
R24830	R24830	24830
R24834	R24834	24834
R24881	24881	24881
R24953	24953	24953
R24969	24969	24969
R2497	2497	6161AS
R2497	R2497	2497
R25437	R25437	25437
R2558	R2558	2558
R259AS	259AS	2456
R259AS	R259AS	259AS
R260Q	260Q	265AR
R260Q	R260Q	260Q
R2611	2611	312AC
R2611	R2611	2611
R2624	2624	2624
R2624A	2624	2624
R2641AS	R2641AS	2641AS
R264AR	264AR	173D
R2676	R2676	2676
R2686	2686	8593AS
R268AE	268AE	673AM
R268AK	268AK	817AL
R2691	2691	2691
R2696	R2696	2696
R270	270	270
R2704	2704	2704
R2729AS	2729AS	890AN
R2729AS	R2729AS	2729AS
R2731	2731	834A
R2761	2761	2761
R2782AS	R2782AS	2782AS
R2793	R2793	2793
R2802	2802	2802
R2835	2835	2835

REFURB. BEARING ASSEMBLY	OUTER RACE S/N	INNER RACE S/N
R2878	2878	2878
R2884	2884	394AE
R288P	R288P	288P
R289AN	289AN	193V
R289AN	R289AN	289AN
R2906	2906	2906
R294S	R294S	294S
R2970	2970	2970
R2978	R2978	2978
R298AN	298AN	5997
R298AN	R298AN	298AN
R3029	3029	3029
R3036	3036	3036
R303AD	303AD	544AH
R303AD	R303AD	303AD
R3075	3075	5767AS
R3075	R3075	3075
R3090	3090	3090
R3100AS	R3100AS	3100AS
R3112	3112	257AR
R3112	R3112	3112
R315AO	R315AO	315AO
R317AN	317AN	4638
R317AN	R317AN	317AN
R318AG	318AG	5208
R318AG	R318AG	318AG
R3205	3205	688AN
R322F	322F	3519AS
R322F	R322F	322F
R3269AS	3269AS	2468AS
R331AM	331AM	4379
R331AM	R331AM	331AM
R3357	3357	23243
R3382	3382	582AF
R3382	R3382	3382
R3383	R3383	3383
R342AN	342AN	751T
R3431	R3431	3431
R343AM	343AM	2168AS
R343AM	R343AM	343AM
R343X	343X	290AG
R3462AS	R3462AS	3462AS
R3475	3475	2423
R3585	3585	7753AS
R3585	R3585	3585
R3593AS	3593AS	3407
R3616	3616	1646
R365AD	365AD	20039
R3666	R3666	3666
R370	R370	370

REFURB. BEARING ASSEMBLY	OUTER RACE S/N	INNER RACE S/N
R375AD	375AD	375AD
R375AF	375AF	S07521
R375AF	R375AF	375AF
R3779	3779	3779
R3781AS	3781AS	1370AS
R3781AS	R3781AS	3781AS
R3791	3791	3791
R380AD	R380AD	380AD
R3835	R3835	3835
R3867AS	R3867AS	3867AS
R3917	3917	4439
R3917	R3917	3917
R3938AS	3938AS	433AP
R3938AS	R3938AS	3938AS
R3959AS	3959AS	3269AS
R396AR	396AR	300G
R4019	R4019	4019
R4054	4054	4191AS
R4054	R4054	4054
R4105	R4105	4105
R4124	4124	5325AS
R4132	4132	195AS
R4135	4135	2318
R4143AS	4143AS	9026AS
R4143AS	R4143AS	4143AS
R4150	R4150	4150
R4186	R4186	4186
R418AT	R418AT	418AT
R4191AS	4191AS	218Z
R4248	R4248	4248
R426AN	R426AN	426AN
R428AB	R428AB	428AB
R4316AS	R4316AS	4316AS
R437AM	437AM	1367AS
R4430AS	4430AS	710AK
R4439	4439	4094
R4463	R4463	4463
R450AK	R450AK	450AK
R4555	4555	20739
R455AL	R455AL	455AL
R4591	R4591	4591
R459AO	R459AO	459AO
R460AJ	R460AJ	460AJ
R4638	4638	738AP
R4694AS	4694AS	1084
R4694AS	R4694AS	4694AS
R471AF	R471AF	471AF
R4733	R4733	4733
R4744	4744	5816
R4744	R4744	4744

AD-A194 932 NONDESTRUCTIVE EVALUATION AND ENDURANCE TESTING OF REFURBISHED T53 ENGINE (U) SOUTHWEST RESEARCH INST SAN ANTONIO TX W D PERRY ET AL DEC 87 2/2

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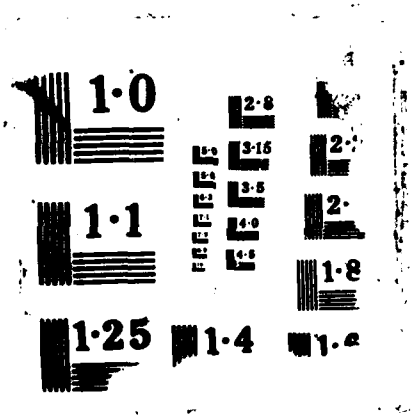
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REFURB. BEARING ASSEMBLY	OUTER RACE S/N	INNER RACE S/N
R477AJ	R477AJ	477AJ
R477C	R477C	477C
R4826AS	4826AS	116AA
R4845	R4845	4845
R507511	R507511	507511
R5186	R5186	5186
R5229	5229	707
R523L	523L	8067AS
R525AD	R525AD	525AD
R527AK	R527AK	527AK
R529V	R529V	529V
R5304	5304	588AR
R5325AS	5325AS	841V
R532AC	532AC	782AE
R534AP	R534AP	534AP
R540AG	R540AG	540AG
R5411AS	5411AS	396AR
R5411AS	R5411AS	5411AS
R543AE	543AE	1063
R543AE	R543AE	543AE
R543AH	R543AH	543AH
R544AH	544AH	928AJ
R545AF	R545AF	545AF
R547AH	547AH	491AF
R5484	5484	3432
R550AH	R550AH	550AH
R555AJ	555AJ	2552
R558AJ	558AJ	3205
R5597AS	5597AS	205AC
R5597AS	R5597AS	5597AS
R5599AS	5599AS	827AJ
R5599AS	R5599AS	5599AS
R567AA	567AA	567AA
R569AP	569AP	5484
R569AP	R569AP	569AP
R5816	5816	314AO
R582AF	582AF	3770
R5851	5851	3959AS
R5851	R5851	5851
R5916	5916	6916
R5923	5923	5923
R5944	5944	606AO
R5944	R5944	5944
R602AP	R602AP	602AP
R604W	R604W	604W
R606AO	606AO	865AG
R606AS	606AS	268AE
R606AS	R606AS	606AS
R6077	6077	2028AS
R6077	R6077	6077

REFURB. BEARING ASSEMBLY	OUTER RACE S/N	INNER RACE S/N
R6081	6081	6081
R6126AS	R6126AS	6126AS
R638AO	R638AO	638AO
R647A	647A	3905AS
R647A	R647A	467A
R649AO	649AO	5892
R649AO	R649AO	649AO
R650AA	R650AA	650AA
R656AG	R656AG	656AG
R666AF	666AP	145Y
R666AP	R666AP	666AP
R667AG	667AG	SO3601
R668Q	R668Q	668Q
R670AK	R670AK	670AK
R6723	6723	6723
R673AM	673AM	3307
R6827	6827	6827
R683G	R683G	683G
R6870	6870	6870
R688AN	688AN	5309
R688L	688L	717AA
R688L	R688L	688L
R6910	6910	6910
R692AO	692AO	381AJ
R692AO	R692AO	692AO
R697	697	235T
R697	R697	697
R697AR	R697AR	697AR
R697I	697I	1952
R697I	R697I	697I
R701AO	R701AO	701AO
R702Q	702Q	672AG
R702Q	R702Q	702Q
R709AD	709AD	173AF
R713	713	713
R717AA	717AA	7775AS
R726U	726U	1637
R726U	R726U	726U
R732L	R732L	732L
R738AP	738AP	7784AS
R741AF	R741AF	741AF
R760G	760G	658M
R760G	R760G	760G
R7653AS	R7653AS	7653AS
R7784AS	7784AS	547AH
R778P	778P	131AV
R778P	R778P	778P
R785AJ	785AJ	854W
R785AJ	R785AJ	785AJ
R785Y	785Y	3088AS

REFURB. BEARING ASSEMBLY	OUTER RACE S/N	INNER RACE S/N
R785Y	R785Y	785Y
R789AT	R789AT	789AT
R794AH	R794AH	794AH
R7957	7957	5837
R7957	R7957	7957
R803G	803G	667AG
R805Z	805Z	712AJ
R817AL	817AL	378AJ
R822G	822G	5304
R822G	R822G	822G
R822R	822R	4011
R827AJ	827AJ	1963AS
R829AC	R829AC	829AC
R831AN	831AN	5410
R833AK	833AK	833AK
R834A	834A	S07541
R834AE	834AE	5651AS
R834AE	R834AE	834AE
R835AN	835AN	805Z
R835AN	R835AN	835AN
R844AM	844AM	228U
R844AM	R844AM	844AM
R8593AS	8593AS	1083
R865AE	865AE	644M
R865AE	R865AE	865AE
R879AJ	879AJ	191AF
R879AJ	R879AJ	879AJ
R880D	R880D	880D
R881AE	881AE	268AK
R881AE	R881AE	881AE
R890AM	890AM	58ZZ
R892AF	R892AF	892AF
R9114AS	R9114AS	9114AS
R919AD	919AD	609F
R919AD	R919AD	919AD
R923AP	923AP	6000
R923AP	R923AP	923AP
R928AJ	928AJ	264AR
R931AP	931AP	931AP
R935AL	935AL	5153
R956AR	956AR	3508AS
R9584AS	R9584AS	9584AS
R9638AS	R9638AS	9638AS
R965AH	965AH	935AL
R965AH	R965AH	965AH
R966AH	966AH	5229
R966AH	R966AH	966AH
R984AH	R984AH	984AH
R985R	985R	739AN
R985R	R985R	985R

REFURB. BEARING ASSEMBLY	OUTER RACE S/N	INNER RACE S/N
R9875	9875	5970
R9875	R9875	9875
R987AP	987AP	890AM
R987AP	R987AP	987AP
R988U	988U	988U
RS05591	S05591	4250AS
RS05601	RS05601	S05601
RS05601	S05601	S05591
RS05991	RS05991	S05991
RS07531	RS07531	S07531

TABLE IV
Inner Race Serial Numbers Cross Referenced To Refurbished Bearing Assembly Serial Numbers and Outer Race Serial Numbers

New outer races manufactured by ITI are identified by an "R" prefix in the outer race serial numbers.

INNER RACE S/N	REFURB. BEARING ASSEMBLY	OUTER RACE S/N
1034AS	R1034AS	R1034AS
103AC	R1391	1391
1063	R543AE	543AE
1064	R1064	R1064
1077	R1077	R1077
1083	R8593AS	8593AS
1084	R4694AS	4694AS
108AD	R108AD	R108AD
1106	R245R	245R
110AN	R245	245
1114AS	R111T	111T
111T	R111T	R111T
113AL	R113AL	R113AL
115Q	R115Q	R115Q
1161AS	R1161AS	R1161AS
116AA	R4826AS	4826AS
125AD	R125AD	R125AD
1271	R1271	R1271
12730	R12730	12730
1302AS	R1302AS	R1302AS
131AV	R778P	778P
131W	R1963AS	1963AS
13459	R13459	13459
1367AS	R437AM	437AM
1370AS	R3781AS	3781AS
138R	R138R	R138R
1391	R1391	R1391
14023	R14023	R14023
144AF	R144AF	144AF
144Q	R144Q	R144Q
14594	R14594	R14594
145Y	R666AF	666AP
14634	R14634	14634
146AE	R146AE	R146AE
1478	R1478	R1478
147AD	R147AD	R147AD
1508	R1508	R1508
1549	R1549	R1549
15529	R15529	15529
15780	R15780	15780
159AH	R205AC	205AC
16030	R16030	16030
16120	R16120	16120
1636	R1636	R1636
1637	R726U	726U
1646	R3616	3616
1649AS	R1649AS	R1649AS
16546	R16546	16546
16914	R12338	12338
1710	R1710	R1710
1731	R1731	R1731
173AF	R709AD	709AD
173D	R264AR	264AR
179X	R179X	R179X
1814	R22774	22774
1821	R1821	R1821
1822	R1814	1814
18250	R18250	18250
1854	R1854	R1854
1856	R1856	1856
1856AS	R1856AS	R1856AS
18719	R18719	18719
1882	R1882	1882
18908	R18908	18908
1909	R1909	1909
1914	R1914	1914
191AF	R879AJ	879AJ
192AR	R179X	179X
193V	R289AN	289AN
19416	R19416	19416
1945	R1945	R1945
1952	R697I	697I
195AS	R4132	4132
1963AS	R827AJ	827AJ
197E	R197E	R197E
20039	R365AD	365AD
2028	R2028	2028
2028AS	R6077	6077
203Z	R203Z	R203Z
205AC	R5597AS	5597AS
205G	R205G	R205G
20739	R4555	4555
2075	R2075	R2075
2085	R2085	R2085

INNER RACE S/N	REFURB. BEARING ASSEMBLY	OUTER RACE S/N
2131AS	R2131AS	R2131AS
215AF	R215AF	R215AF
2168AS	R343AM	343AM
21845	R21845	21845
218AP	R218AP	R218AP
218Y	R218Y	R218Y
218Z	R4191AS	4191AS
22189	R22189	R22189
2223	R2223	R2223
2226	R2226	2226
2244	R2244	R2244
22514	R22514	22514
2254	R2254	R2254
22565	R2223	2223
22598	R22598	22598
2274	R2274	2274
22774	R14594	14594
22836	R22836	22836
2283AS	R2020	2020
228U	R844AM	844AM
230AL	R230AL	R230AL
2318	R4135	4135
23243	R3357	3357
2325	R2325	2325
23317	R23317	23317
23356	R23356	R23356
2344AS	R2344AS	R2344AS
23467	R23467	23467
2358	R2358	R2358
23582	R23582	23582
235T	R697	697
23636	R23636	R23636
23638	R2318	2318
23792	R23792	23792
2382AS	R2382AS	R2382AS
238AO	R238AO	R238AO
2390AS	R2390AS	R2390AS
2391	R2391	2391
2393AS	R2393AS	2393AS
2414	R2414	R2414
241AX	R241AX	R241AX
2423	R3475	3475
24257	R24257	24257
2430AS	R20039	20039
2434	R1114AS	1114AS
24349	R24349	24349
243AC	R243AC	R243AC
24409	R24409	24409
24495	R14023	14023
24514	R24514	24514

INNER RACE S/N	REFURB. BEARING ASSEMBLY	OUTER RACE S/N
24533	R24533	24533
2456	R259AS	259AS
24575	R24575	R24575
24594	R24594	24594
245AO	R245AO	245AO
24606	R24606	24606
2467	R2467	2467
24676	R24676	R24676
24689	R24689	R24689
2468AS	R3269AS	3269AS
24690	R24690	24690
24761	R24761	24761
24830	R24830	R24830
24834	R24834	R24834
24881	R24881	24881
24953	R24953	24953
24969	R24969	24969
2497	R2497	R2497
25437	R25437	R25437
2552	R555AJ	555AJ
2558	R2558	R2558
257AR	R3112	3112
259AS	R259AS	R259AS
260Q	R260Q	R260Q
2611	R2611	R2611
2624	R2624	2624
2624	R2624A	2624
2641AS	R2641AS	R2641AS
264AR	R928AJ	928AJ
265AR	R260Q	260Q
2676	R2676	R2676
268AE	R606AS	606AS
268AK	R881AE	881AE
2691	R2691	2691
2696	R2696	R2696
270	R270	270
2704	R2704	2704
2729AS	R2729AS	R2729AS
2731	R2430AS	2430AS
2761	R2761	2761
2782AS	R2782AS	R2782AS
2793	R2793	R2793
2802	R2802	2802
2835	R2835	2835
2867	R17719	17719
2878	R2878	2878
2884	R159AH	159AH
288P	R288P	R288P
289AN	R289AN	R289AN
2906	R2906	2906

INNER RACE S/N	REFURB. BEARING ASSEMBLY	OUTER RACE S/N
290AG	R343X	343X
294S	R294S	R294S
2970	R2970	2970
2978	R2978	R2978
298AN	R298AN	R298AN
300G	R396AR	396AR
3029	R3029	3029
3036	R3036	3036
303AD	R303AD	R303AD
3054AS	R1077	1077
305AS	R197E	197E
3075	R3075	R3075
3088AS	R785Y	785Y
3090	R3090	3090
3100AS	R3100AS	R3100AS
3112	R3112	R3112
312AC	R2611	2611
314AO	R5816	5816
315AO	R315AO	R315AO
317AN	R317AN	R317AN
318AG	R318AG	R318AG
3205	R558AJ	558AJ
322AD	R2028AS	2028AS
322F	R322F	R322F
3269AS	R3959AS	3959AS
3307	R673AM	673AM
331AM	R331AM	R331AM
3357	R16914	16914
338	R1084	1084
3382	R3382	R3382
3383	R3383	R3383
3407	R3593AS	3593AS
3431	R3431	R3431
3432	R5484	5484
343AM	R343AM	R343AM
3462AS	R3462AS	R3462AS
3508AS	R956AR	956AR
3519AS	R322F	322F
3585	R3585	R3585
3593AS	R1636	1636
3666	R3666	R3666
370	R370	R370
3731	R2254	2254
375AD	R375AD	375AD
375AF	R375AF	R375AF
3770	R582AF	582AF
3779	R3779	3779
3781AS	R3781AS	R3781AS
378AJ	R817AL	817AL
3791	R3791	3791

INNER RACE S/N	REFURB. BEARING ASSEMBLY	OUTER RACE S/N
380AD	R380AD	R380AD
381AJ	R692AO	692AO
3835	R3835	R3835
3867AS	R3867AS	R3867AS
3905AS	R647A	647A
3917	R3917	R3917
3938AS	R3938AS	R3938AS
394AE	R2884	2884
3959AS	R5851	5851
396AR	R5411AS	5411AS
4011	R822R	822R
4019	R4019	R4019
4054	R4054	R4054
4094	R4439	4439
4105	R4105	R4105
4124	R145Y	145Y
4132	R1856AS	1856AS
4135	R13140	13140
4143AS	R4143AS	R4143AS
4150	R4150	R4150
4186	R4186	R4186
418AT	R418AT	R418AT
4191AS	R4054	4054
4228AS	R110AN	110AN
4248	R4248	R4248
4250AS	RS05591	S05591
426AN	R426AN	R426AN
428AB	R428AB	R428AB
4316AS	R4316AS	R4316AS
433AP	R3938AS	3938AS
4379	R331AM	331AM
437AM	R218Y	218Y
4430AS	R2182	2182
4439	R3917	3917
4463	R4463	R4463
449AG	R108AD	108AD
450AK	R450AK	R450AK
455AL	R455AL	R455AL
4591	R4591	R4591
459AO	R459AO	R459AO
460AJ	R460AJ	R460AJ
4638	R317AN	317AN
467A	R647A	R647A
4694AS	R4694AS	R4694AS
471AF	R471AF	R471AF
4733	R4733	R4733
4744	R4744	R4744
477AJ	R477AJ	R477AJ
477C	R477C	R477C
4845	R4845	R4845

INNER RACE S/N	REFURB. BEARING ASSEMBLY	OUTER RACE S/N
489AE	R195AS	195AS
491AF	R547AH	547AH
507511	R507511	R507511
5153	R935AL	935AL
5186	R5186	R5186
5208	R318AG	318AG
5229	R966AH	966AH
523L	R1508	1508
525AD	R525AD	R525AD
527AK	R527AK	R527AK
529V	R529V	R529V
5304	R822G	822G
5309	R688AN	688AN
5317	R24495	24495
5325AS	R4124	4124
532AC	R2468AS	2468AS
534AP	R534AP	R534AP
5368AS	R2131AS	2131AS
540AG	R540AG	R540AG
5410	R831AN	831AN
5411AS	R5411AS	R5411AS
543AE	R543AE	R543AE
543AH	R543AH	R543AH
544AH	R303AD	303AD
545AF	R545AF	R545AF
547AH	R7784AS	7784AS
5484	R569AP	569AP
550AH	R550AH	R550AH
558AJ	R1302AS	1302AS
5597AS	R5597AS	R5597AS
5599AS	R5599AS	R5599AS
5651AS	R834AE	834AE
567AA	R567AA	567AA
569AP	R569AP	R569AP
5737	R23243	23243
5767AS	R3075	3075
5816	R4744	4744
582AF	R3382	3382
5837	R7957	7957
5851	R5851	R5851
5859	R2456	2456
588AR	R5304	5304
5892	R649AO	649AO
58ZZ	R890AM	890AM
5923	R5923	5923
5944	R5944	R5944
5970	R9875	9875
5997	R298AN	298AN
6000	R923AP	923AP
602AP	R602AP	R602AP
604W	R604W	R604W
606AO	R5944	5944
606AS	R606AS	R606AS
6077	R6077	R6077
6081	R6081	6081
609F	R919AD	919AD
6126AS	R6126AS	R6126AS
6161AS	R2497	2497
638AO	R638AO	R638AO
644M	R865AE	865AE
649AO	R649AO	R649AO
650AA	R650AA	R650AA
656AG	R656AG	R656AG
658M	R760G	760G
666AP	R666AP	R666AP
667AG	R803G	803G
668Q	R668Q	R668Q
670AK	R670AK	R670AK
6723	R6723	6723
672AG	R702Q	702Q
673AM	R268AE	268AE
6827	R6827	6827
683G	R683G	R683G
6870	R6870	6870
688AN	R3205	3205
688L	R688L	R688L
6910	R6910	6910
6916	R5916	5916
692AO	R692AO	R692AO
694AS	R1370AS	1370AS
697	R697	R697
697AR	R697AR	R697AR
697I	R697I	R697I
701AO	R701AO	R701AO
702Q	R702Q	R702Q
707	R5229	5229
709AO	R2085	2085
710AK	R4430AS	4430AS
712AJ	R805Z	805Z
713	R713	713
717AA	R688L	688L
726U	R726U	R726U
732L	R732L	R732L
734AN	R2168AS	2168AS
738AP	R4638	4638
739AN	R985R	985R
741AF	R741AF	R741AF
751T	R342AN	342AN
753AS	R215AF	215AF
760G	R760G	R760G

INNER RACE S/N	REFURB. BEARING ASSEMBLY	OUTER RACE S/N
7653AS	R7653AS	R7653AS
7753AS	R3585	3585
7775AS	R717AA	717AA
7784AS	R738AP	738AP
778P	R778P	R778P
782AE	R532AC	532AC
785AJ	R785AJ	R785AJ
785Y	R785Y	R785Y
789AT	R789AT	R789AT
794AH	R794AH	R794AH
7957	R7957	R7957
803G	R2382AS	2382AS
805Z	R835AN	835AN
8067AS	R523L	523L
817AL	R268AK	268AK
822G	R822G	R822G
827AJ	R5599AS	5599AS
829AC	R829AC	R829AC
833AK	R833AK	833AK
834A	R2731	2731
834AE	R834AE	R834AE
835AN	R835AN	R835AN
841V	R5325AS	5325AS
844AM	R844AM	R844AM
854W	R785AJ	785AJ
856AG	R235T	235T
8593AS	R2686	2686
865AE	R865AE	R865AE
865AG	R606AO	606AO
879AJ	R879AJ	R879AJ
880D	R880D	R880D
881AE	R881AE	R881AE
890AM	R987AP	987AP
890AN	R2729AS	2729AS
892AF	R892AF	R892AF
9026AS	R4143AS	4143AS
9114AS	R9114AS	R9114AS
912X	R2244	2244
919AD	R919AD	R919AD
923AP	R923AP	R923AP
928AJ	R544AH	544AH
931AP	R931AP	931AP
935AL	R965AH	965AH
958	R1549	1549
9584AS	R9584AS	R9584AS
9638AS	R9638AS	R9638AS
965AH	R965AH	R965AH
966AH	R966AH	R966AH
984AH	R984AH	R984AH
985R	R985R	R985R
9875	R9875	R9875
987AP	R987AP	R987AP
988U	R988U	988U
S05591	RS05601	S05601
S05601	RS05601	RS05601
S05991	RS05991	RS05991
S07521	R375AF	375AF
S07531	RS07531	RS07531
S07541	R834A	834A
SO3601	R667AG	667AG

TABLE V
Outer Race Serial Numbers Cross Referenced To Refurbished Bearing Assembly Serial Numbers and Inner Race Serial Numbers

New outer races manufactured by ITI are identified by an "R" prefix in the outer race serial numbers.

OUTER RACE S/N	REFURB. BEARING ASSEMBLY	INNER RACE S/N	OUTER RACE S/N	REFURB. BEARING ASSEMBLY	INNER RACE S/N
1077	R1077	3054AS	197E	R197E	305AS
1084	R1084	338	20039	R20039	2430AS
108AD	R108AD	449AG	2020	R2020	2283AS
110AN	R110AN	4228AS	2028	R2028	2028
1114AS	R1114AS	2434	2028AS	R2028AS	322AD
111T	R111T	1114AS	205AC	R205AC	159AH
12338	R12338	16914	2085	R2085	709AO
12730	R12730	12730	2131AS	R2131AS	5368AS
1302AS	R1302AS	558AJ	215AF	R215AF	753AS
13140	R13140	4135	2168AS	R2168AS	734AN
13459	R13459	13459	2182	R2182	4430AS
1370AS	R1370AS	694AS	21845	R21845	21845
1391	R1391	103AC	218Y	R218Y	437AM
14023	R14023	24495	2223	R2223	22565
144AF	R144AF	144AF	2226	R2226	2226
14594	R14594	22774	2244	R2244	912X
145Y	R145Y	4124	22514	R22514	22514
14634	R14634	14634	2254	R2254	3731
1508	R1508	523L	22598	R22598	22598
1549	R1549	958	2274	R2274	2274
15529	R15529	15529	22774	R22774	1814
15780	R15780	15780	22836	R22836	22836
159AH	R159AH	2884	2318	R2318	23638
16030	R16030	16030	23243	R23243	5737
16120	R16120	16120	2325	R2325	2325
1636	R1636	3593AS	23317	R23317	23317
16546	R16546	16546	23467	R23467	23467
16914	R16914	3357	23582	R23582	23582
17719	R17719	2867	235T	R235T	856AG
179X	R179X	192AR	23792	R23792	23792
1814	R1814	1822	2382AS	R2382AS	803G
18250	R18250	18250	2391	R2391	2391
1856	R1856	1856	2393AS	R2393AS	2393AS
1856AS	R1856AS	4132	24257	R24257	24257
18719	R18719	18719	2430AS	R2430AS	2731
1882	R1882	1882	24349	R24349	24349
18908	R18908	18908	24409	R24409	24409
1909	R1909	1909	24495	R24495	5317
1914	R1914	1914	245	R245	110AN
19416	R19416	19416	24514	R24514	24514
195AS	R195AS	489AE	24533	R24533	24533
1963AS	R1963AS	131W	2456	R2456	5859

OUTER RACE S/N	REFURB. BEARING ASSEMBLY	INNER RACE S/N
24594	R24594	24594
245AO	R245AO	245AO
245R	R245R	1106
24606	R24606	24606
2467	R2467	2467
2468AS	R2468AS	532AC
24690	R24690	24690
24761	R24761	24761
24881	R24881	24881
24953	R24953	24953
24969	R24969	24969
2497	R2497	6161AS
259AS	R259AS	2456
260Q	R260Q	265AR
2611	R2611	312AC
2624	R2624	2624
2624	R2624A	2624
264AR	R264AR	173D
2686	R2686	8593AS
268AE	R268AE	673AM
268AK	R268AK	817AL
2691	R2691	2691
270	R270	270
2704	R2704	2704
2729AS	R2729AS	890AN
2731	R2731	834A
2761	R2761	2761
2802	R2802	2802
2835	R2835	2835
2878	R2878	2878
2884	R2884	394AE
289AN	R289AN	193V
2906	R2906	2906
2970	R2970	2970
298AN	R298AN	5997
3029	R3029	3029
3036	R3036	3036
303AD	R303AD	544AH
3075	R3075	5767AS
3090	R3090	3090
3112	R3112	257AR
317AN	R317AN	4638
318AG	R318AG	5208
3205	R3205	688AN
322F	R322F	3519AS
3269AS	R3269AS	2468AS
331AM	R331AM	4379
3357	R3357	23243
3382	R3382	582AF
342AN	R342AN	751T
343AM	R343AM	2168AS
343X	R343X	290AG
3475	R3475	2423
3585	R3585	7753AS
3593AS	R3593AS	3407
3616	R3616	1646
365AD	R365AD	20039
375AD	R375AD	375AD
375AF	R375AF	S07521
3779	R3779	3779
3781AS	R3781AS	1370AS
3791	R3791	3791
3917	R3917	4439
3938AS	R3938AS	433AP
3959AS	R3959AS	3269AS
396AR	R396AR	300G
4054	R4054	4191AS
4124	R4124	5325AS
4132	R4132	195AS
4135	R4135	2318
4143AS	R4143AS	9026AS
4191AS	R4191AS	218Z
437AM	R437AM	1367AS
4430AS	R4430AS	710AK
4439	R4439	4094
4555	R4555	20739
4638	R4638	738AP
4694AS	R4694AS	1084
4744	R4744	5816
4826AS	R4826AS	116AA
5229	R5229	707
523L	R523L	8067AS
5304	R5304	588AR
5325AS	R5325AS	841V
532AC	R532AC	782AE
5411AS	R5411AS	396AR
543AE	R543AE	1063
544AH	R544AH	928AJ
547AH	R547AH	491AF
5484	R5484	3432
555AJ	R555AJ	2552
558AJ	R558AJ	3205
5597AS	R5597AS	205AC
5599AS	R5599AS	827AJ
567AA	R567AA	567AA
569AP	R569AP	5484
5816	R5816	314AO
582AF	R582AF	3770
5851	R5851	3959AS
5916	R5916	6916

OUTER RACE S/N	REFURB. BEARING ASSEMBLY	INNER RACE S/N
5923	R5923	5923
5944	R5944	606AO
606AO	R606AO	865AG
606AS	R606AS	268AE
6077	R6077	2028AS
6081	R6081	6081
647A	R647A	3905AS
649AO	R649AO	5892
666AP	R666AF	145Y
667AG	R667AG	SO3601
6723	R6723	6723
673AM	R673AM	3307
6827	R6827	6827
6870	R6870	6870
688AN	R688AN	5309
688L	R688L	717AA
6910	R6910	6910
692AO	R692AO	381AJ
697	R697	235T
697I	R697I	1952
702Q	R702Q	672AG
709AD	R709AD	173AF
713	R713	713
717AA	R717AA	7775AS
726U	R726U	1637
738AP	R738AP	7784AS
760G	R760G	658M
7784AS	R7784AS	547AH
778P	R778P	131AV
785AJ	R785AJ	854W
785Y	R785Y	3088AS
7957	R7957	5837
803G	R803G	667AG
805Z	R805Z	712AJ
817AL	R817AL	378AJ
822G	R822G	5304
822R	R822R	4011
827AJ	R827AJ	1963AS
831AN	R831AN	5410
833AK	R833AK	833AK
834A	R834A	S07541
834AE	R834AE	5651AS
835AN	R835AN	805Z
844AM	R844AM	228U
8593AS	R8593AS	1083
865AE	R865AE	644M
879AJ	R879AJ	191AF
881AE	R881AE	268AK
890AM	R890AM	58ZZ
919AD	R919AD	609F

OUTER RACE S/N	REFURB. BEARING ASSEMBLY	INNER RACE S/N
923AP	R923AP	6000
928AJ	R928AJ	264AR
931AP	R931AP	931AP
935AL	R935AL	5153
956AR	R956AR	3508AS
965AH	R965AH	935AL
966AH	R966AH	5229
985R	R985R	739AN
9875	R9875	5970
987AP	R987AP	890AM
988U	R988U	988U
R1034AS	R1034AS	1034AS
R1064	R1064	1064
R1077	R1077	1077
R108AD	R108AD	108AD
R111T	R111T	111T
R113AL	R113AL	113AL
R115Q	R115Q	115Q
R1161AS	R1161AS	1161AS
R125AD	R125AD	125AD
R1271	R1271	1271
R1302AS	R1302AS	1302AS
R138R	R138R	138R
R1391	R1391	1391
R14023	R14023	14023
R144Q	R144Q	144Q
R14594	R14594	14594
R146AE	R146AE	146AE
R1478	R1478	1478
R147AD	R147AD	147AD
R1508	R1508	1508
R1549	R1549	1549
R1636	R1636	1636
R1649AS	R1649AS	1649AS
R1710	R1710	1710
R1731	R1731	1731
R179X	R179X	179X
R1821	R1821	1821
R1854	R1854	1854
R1856AS	R1856AS	1856AS
R1945	R1945	1945
R197E	R197E	197E
R203Z	R203Z	203Z
R205G	R205G	205G
R2075	R2075	2075
R2085	R2085	2085
R2131AS	R2131AS	2131AS
R215AF	R215AF	215AF
R218AP	R218AP	218AP
R218Y	R218Y	218Y

OUTER RACE S/N	REFURB. BEARING ASSEMBLY	INNER RACE S/N
R22189	R22189	22189
R2223	R2223	2223
R2244	R2244	2244
R2254	R2254	2254
R230AL	R230AL	230AL
R23356	R23356	23356
R2344AS	R2344AS	2344AS
R2358	R2358	2358
R23636	R23636	23636
R2382AS	R2382AS	2382AS
R238AO	R238AO	238AO
R2390AS	R2390AS	2390AS
R2414	R2414	2414
R241AX	R241AX	241AX
R243AC	R243AC	243AC
R24575	R24575	24575
R24676	R24676	24676
R24689	R24689	24689
R24830	R24830	24830
R24834	R24834	24834
R2497	R2497	2497
R25437	R25437	25437
R2558	R2558	2558
R259AS	R259AS	259AS
R260Q	R260Q	260Q
R2611	R2611	2611
R2641AS	R2641AS	2641AS
R2676	R2676	2676
R2696	R2696	2696
R2729AS	R2729AS	2729AS
R2782AS	R2782AS	2782AS
R2793	R2793	2793
R288P	R288P	288P
R289AN	R289AN	289AN
R294S	R294S	294S
R2978	R2978	2978
R298AN	R298AN	298AN
R303AD	R303AD	303AD
R3075	R3075	3075
R3100AS	R3100AS	3100AS
R3112	R3112	3112
R315AO	R315AO	315AO
R317AN	R317AN	317AN
R318AG	R318AG	318AG
R322F	R322F	322F
R331AM	R331AM	331AM
R3382	R3382	3382
R3383	R3383	3383
R3431	R3431	3431
R343AM	R343AM	343AM

OUTER RACE S/N	REFURB. BEARING ASSEMBLY	INNER RACE S/N
R3462AS	R3462AS	3462AS
R3585	R3585	3585
R3666	R3666	3666
R370	R370	370
R375AF	R375AF	375AF
R3781AS	R3781AS	3781AS
R380AD	R380AD	380AD
R3835	R3835	3835
R3867AS	R3867AS	3867AS
R3917	R3917	3917
R3938AS	R3938AS	3938AS
R4019	R4019	4019
R4054	R4054	4054
R4105	R4105	4105
R4143AS	R4143AS	4143AS
R4150	R4150	4150
R4186	R4186	4186
R418AT	R418AT	418AT
R4248	R4248	4248
R426AN	R426AN	426AN
R428AB	R428AB	428AB
R4316AS	R4316AS	4316AS
R4463	R4463	4463
R450AK	R450AK	450AK
R455AL	R455AL	455AL
R4591	R4591	4591
R459AO	R459AO	459AO
R460AJ	R460AJ	460AJ
R4694AS	R4694AS	4694AS
R471AF	R471AF	471AF
R4733	R4733	4733
R4744	R4744	4744
R477AJ	R477AJ	477AJ
R477C	R477C	477C
R4845	R4845	4845
R507511	R507511	507511
R5186	R5186	5186
R525AD	R525AD	525AD
R527AK	R527AK	527AK
R529V	R529V	529V
R534AP	R534AP	534AP
R540AG	R540AG	540AG
R5411AS	R5411AS	5411AS
R543AE	R543AE	543AE
R543AH	R543AH	543AH
R545AF	R545AF	545AF
R550AH	R550AH	550AH
R5597AS	R5597AS	5597AS
R5599AS	R5599AS	5599AS
R569AP	R569AP	569AP

END
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