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JAN 23 1995

DETECTOR ARRAY DESIGN

OSTI

PREPARED BY

SAEED LARI

FOR

METAL AND CERAMIC DIVISION
OAK-RIDGE NATIONAL LAB

SPONSORED BY

NUCLEAR REGULATORY COMMISSION

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INTRODUCTION

Neutron scattering facility at Oak-Ridge National is used to measure residual stresses in many different materials. Neutron beam from the reactor can be used to penetrate the inner atomic distances of metals which then can be diffracted to a detector to measure the strain. The strain data later can be converted to stresses.

The facility currently uses only one detector to carry the measurement. By designing an array of detectors data can be obtained at a much faster rate and or having a much better and improved resolution.

The purpose of this report is to show design of such array of detectors and their movements (rotation) for possible maximum data collection at a faster rate.

DESIGN PROCESS

A distance of 1 meter or 39.37 inches selected from the face of detector to the center of test specimen. Based on this distance and the fact that detectors were required to rotate about their faces and also had to be able to rotate them all together based on the center of specimen a curved frame was designed.

Since detectors had to be packed as close as possible and also had to have rotating capability raised challenging design criteria.

Many different designs were considered. Finally it was decided to automate the rotation process by employing motors to do the task.

Detector manufacture was asked to modify the detector for possible reduction in height to accommodate closer packing of detectors.

Since detectors would be rotated by use of motors two plates (parts) were required to accomplish the task. One plate would be connected to the detector and one would hold the motor, detector assembly and also be connected to a frame. This would require the use of bearings. Figure one and 1A show the assembly or plate which would be connected to the frame. This assembly can be connected to the frame by use of 0.3125 diameter hex socket cap screws about 1.875 inches long (stainless steel). Bearings are of high quality made for air-plane by FAFNIR (numbers 206k, and 203K). It must be mentioned that figure one has to be detailed before manufacturing. Bearings MUST BE PRESS-FIT. Schedule of tolerances needed for detailing is provided in appendix.

Design of this part is based on the physical size of the motor (size 23) from CyberResearch. Any change in size of motor will require modification of top plate assembly (Figure 1) and the frame.

Material can be any high quality stainless steel such as 304 steel.

Figure 2 and 2A show the plate which will be connected to detector and in turn to top plate assembly. Tolerances not shown but can be extracted from appendix. Figure 2 also shows posts which will connect the two assembly together. Currently these posts (4 required 6 can be used) are three inches long and they might have to be longer incase of interference from cables extruding from the back of detectors. These posts will be screwed in the detector on one side and will be fastened to top plate by use of 1/4 inch ss nuts.

Figure 3 shows detail of frame. It can be manufactured from any high quality steel (high yield stress 50000 psi or more). Figure three must be fully detailed before manufacturing. Base plate detail drawing included in appendix. Frame will be welded to base plate which in turn will be bolted to an arm. Fillet weld of 1/4 inch selected for all bracings. Figures 4 and 5 show locations and sizes of welds.

Figures 6 and 7 show compete design of detector array. If steel is used for the frame and associated parts a total weight of 180 to 220 LB can be expected.

Autocad version 12 was used in conjunction with DOS 5.0. Design is in 3D and more information such as center of gravity, mass, volume, and inertia can be extracted from files. A diskette which contains 6 files will be included with this report.

RECOMMENDATIONS

Currently design is based on the fact that 3 inch long posts are used to create ample space so cables and their connectors no to have interference with the frame. The length of theses post can be shortened if cable connectors can be moved closer to the edges of detector. It is recommended to investigate this idea with the detector manufacturer. This change also causes less stain on the motor and cables.

DRAWING FILES

Total of six files are provided with the accompanying diskett. Files are as follow:

1- FTP3D.DWG This file is excellent for viewing on the entire design. All surfaces are meshed and hidden lines can be removed for ease of viewing and also the total assembly can be shaded.

2-FF3D.DWG . This file contains the whole design in 3D space. Modifications are possible with this file. Design is a SOLID MODEL so information such as center of gravity and volume may be extracted.

3-FRDETAIL.DWG Partial detail of frame is located with this file.

4-STDET.B.DWG This file contains partial detail of bottom plate.

5-STDET.DWG This file contains partial detail of top plate.

6-DET6.DWG Rotations and shifting of detectors are in this file.

or Trans
Motor
or Key
SHAFT HOLE
WITH SPACER

FIGURE 1.TOP ASSEMBLY

FIGURE 2-BOTTOM PLATE ASSEMBLY

FIGURE 2A-BOTTOM PLATE
ASSEMBLY IN 3D.

1-ALL MATERIALS STEEL
4150
2-7 HOLES ON BOTH FRAMES
5/16 18 UNC 2B TAP ALL THE
WAY THROUGH ON 17 DEGREE
ARC EQUALLY SPACED.
3-ALL BRACINGS 1/2 THICK

FIGURE 4- WELDING LOCATION AND
FIGURE 1/4 FILLET LINES
SIZE 1/4 AND
BLACK

FIGURE 5-LOCATION AND SIZE OF WELDS FOR TWO
SUPPORTING BRACES BETWEEN FRAMS. 1/4 FILLET
WELD SHOWN IN BLACK LINES ON EACH
SIDE

FIGURE 6-1 FRAME, BASE DETECTOR
AND CENTER PLATE ASSEMBLY.

FIGURE 7-TECTORS.
AND 7-FRAME, BASE PLATE,

FIGURE 8-INTERFERENCE OF CONNECTORS
WITH FRAME DUE TO ROTATION.

REVISIONS			
LT#	DESCRIPTION	DATE	APPROV.
A	PRELIMINARY

DIMENSIONS IN INCHES

ITEM	QTY	DOC./PART NO.	REV.	DESCRIPTION
<p>VALUES ENGINE SPECIFIED TOLERANCES ARE:</p> <p>FRACTIONS DEC. IN 1/16 1/16 DEC. IN 1/32 1/32 DEC. IN 1/64 1/64 DEC. IN 1/128 1/128 DEC. IN 1/256 1/256 DEC. IN 1/512 1/512 DEC. IN 1/1024 1/1024 DEC. IN 1/2048 1/2048 DEC. IN 1/4096 1/4096 DEC. IN 1/8192 1/8192 DEC. IN 1/16384 1/16384 DEC. IN 1/32768 1/32768 DEC. IN 1/65536 1/65536 DEC. IN 1/131072 1/131072 DEC. IN 1/262144 1/262144 DEC. IN 1/524288 1/524288 DEC. IN 1/1048576 1/1048576 DEC. IN 1/2097152 1/2097152 DEC. IN 1/4194304 1/4194304 DEC. IN 1/8388608 1/8388608 DEC. IN 1/16777216 1/16777216 DEC. IN 1/33554432 1/33554432 DEC. IN 1/67108864 1/67108864 DEC. IN 1/134217728 1/134217728 DEC. IN 1/268435456 1/268435456 DEC. IN 1/536870912 1/536870912 DEC. IN 1/1073741824 1/1073741824 DEC. IN 1/2147483648 1/2147483648 DEC. IN 1/4294967296 1/4294967296 DEC. IN 1/8589934592 1/8589934592 DEC. IN 1/17179869184 1/17179869184 DEC. IN 1/34359738368 1/34359738368 DEC. IN 1/68719476736 1/68719476736 DEC. IN 1/137438953472 1/137438953472 DEC. 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REVISION			DATE
REV	DESCRIPTION		
A	WAS 0.78, NOW 0.87 WAS .31, NOW .33 WAS .30 (REF), NOW .89 (REF) ADDED .31 DIA		6/22/94

FABRICATION DEPARTMENT Work Control	
Procedures Required	Check Job Requirements
Material Mill Test Report (Certified)	SEE NOTE 1
Weld & Braze Inspection Report	
Heat Treat Report	
Deviation Request	
Dimensional Report	NOTE 2
Functional Test Report	
Other Work Requirements	
None of the Above	
LOWER Name	12/16/93 Date

NOTES

1. ALL MATERIAL SPECIFICATIONS SHALL STAY WITH PACKAGE.

DIMENSIONAL

2. ALL GEOMETRIC TOLERANCES AND DIMENSIONS INDICATED BY Δ SHALL BE INSPECTED. INSPECTION REPORTS SHALL REMAIN WITH PACKAGE.

3. ORIENTATION OF HOLES CRITICAL. ARRANGE AS SHOWN.

NEXT ASSEMBLY

THIS DRAWING
PRODUCED ON AUTOCAD
**DO NOT
REVISE MANUALLY**
TOLERANCES
(UNLESS OTHERWISE SPECIFIED)
FRACTIONS $\pm 1/16$

2	1	9.81 x 12 x 1.065	4150
1	1	10.5 x 19.75 x 1.25	4150

MARTIN MARIETTA
ENGINEERING

SOLID STATE DIVISION
OAK RIDGE, TN 37831

TITLE
SPOOL SUPPORT PLATES

HFR SPECTROMETER

DATE: 12/16/93 DRAWN: 11/20/93

RADIAL BEARINGS

Light 200K Series

The Light 200K Series, Conrad-type bearing is well balanced with deep races and uninterrupted race shoulders. Being an excellent, general purpose bearing, it has the capacity to carry radial, thrust in either direction or combined loads.

These bearings are electric motor quality for applications where extra quietness is a requirement.

DIMENSIONS — TOLERANCES

Bearing Number	Bore d				Outside Diameter D				Width C				Fillet Radius ¹⁾		Wt.		Static Load Rating Co		Extended Dynamic Load Rating Ca	
	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	lbs.	kg	lbs.	N	lbs.	N
200K	.3637	10	.0003	.008	1.1411	30	.00035	.009	.3543	9	.005	.12	.024	3	.06	.027	600	2650	1500	6500
201K	.4724	12	.0003	.008	1.2508	32	.00045	.011	.3637	10	.005	.12	.024	3	.06	.036	800	3000	1700	7500
202K	.5906	15	.0003	.008	1.3780	35	.00045	.011	.4331	11	.005	.12	.024	5	.09	.041	780	3450	1900	8600
203K	.6693	17	.0003	.008	1.5748	40	.00045	.011	.4724	12	.005	.12	.024	3	.14	.064	1000	3400	2360	10600
204K	.7874	20	.0004	.010	1.8504	47	.00045	.011	.5512	14	.005	.12	.039	3	.23	.104	1400	5200	3200	14300
205K	.9243	25	.0004	.010	2.0472	52	.0005	.013	.5808	15	.005	.12	.039	13	.28	.127	1560	6950	3450	15300
206K	1.1811	30	.0004	.010	2.4409	62	.0005	.013	.8299	18	.005	.12	.039	3	.43	.195	2280	10000	4800	21600
207K	1.3780	35	.00045	.012	2.8346	72	.0005	.013	.8693	17	.005	.12	.039	3	.64	.290	3050	13700	8400	29500
208K	1.5748	40	.00045	.012	3.1496	80	.0005	.013	.7087	18	.005	.12	.039	3	.83	.376	4000	17600	11500	36000
209K	1.7717	45	.00045	.012	3.3465	85	.0006	.015	.7480	19	.005	.12	.039	19	.94	.428	4000	17600	8150	36000
210K	1.9685	50	.00045	.012	3.6433	90	.0006	.015	.7874	20	.005	.12	.039	3	1.05	.476	4500	19600	8800	39000
211K	2.1854	55	.0006	.015	3.9370	100	.0006	.015	.8268	21	.006	.15	.064	3	1.40	.635	5600	25000	10800	48000
212K	2.3622	60	.0006	.015	4.2307	110	.0006	.015	.8661	22	.008	.15	.069	3	1.78	.807	6850	31000	12900	58000
213K	2.5591	65	.0006	.015	4.7244	120	.0008	.015	.9055	23	.008	.15	.069	3	2.24	1.018	7800	34000	14000	63000
214K	2.7559	70	.0008	.015	4.9213	125	.0007	.013	.9449	24	.008	.15	.069	3	2.44	1.107	8500	37500	15600	69700
216K	2.9528	75	.0008	.015	5.1181	130	.0007	.013	.9843	25	.008	.15	.069	3	2.64	1.198	8500	37500	15300	68000
216K	3.1496	80	.0008	.015	5.5110	140	.0007	.018	1.0238	26	.008	.15	.079	3	3.27	1.483	10200	45000	18000	80000
217K	3.3465	85	.0008	.020	5.9055	150	.0007	.018	1.1024	28	.008	.20	.079	3	4.10	1.860	11800	52000	20800	93000
218K	3.5433	90	.0008	.020	6.2992	160	.0010	.025	1.1811	30	.008	.20	.079	3	4.87	2.209	13700	61000	24000	106000
220K	3.9370	100	.0008	.020	7.0666	180	.0010	.025	1.3398	34	.008	.20	.080	3	8.06	4.07	20800	93000	30500	134000
221K	4.1339	105	.0008	.020	7.4603	190	.0012	.030	1.4173	36	.008	.20	.080	3	8.32	3.77	20800	93000	28500	127000
222K	4.3307	110	.0008	.020	7.8740	200	.0012	.030	1.4961	38	.008	.20	.080	3	9.47	4.30	26000	116000	30000	130000
224K	4.7244	120	.0008	.020	8.4646	215	.0012	.030	1.6535	42	.008	.20	.080	3	15.56	7.06	29000	129000	39000	173000
226K	5.1181	130	.0010	.025	9.0551	230	.0012	.030	1.8110	46	.010	.25	.098	3	14.63	6.64	32500	146000	41500	186000
228K	5.5118	140	.0010	.025	9.8425	250	.0012	.030	1.9685	50	.010	.25	.098	3	24.68	11.19	40000	170000	47500	212000
230K	5.9055	150	.0010	.025	10.6299	270	.0014	.035	1.7717	45	.010	.25	.098	3	28.8	12.1	44000	190000	51000	224000
232K	6.2992	160	.0010	.025	11.4173	290	.0014	.035	1.8268	48	.010	.25	.098	3	33.1	15.0	48000	212000	54000	242000
234K	6.6929	170	.0010	.025	12.2047	310	.0014	.035	2.0472	52	.010	.25	.120	3	41.1	18.7	57000	250000	60000	268000
236K	7.0666	180	.0010	.025	12.5984	320	.0016	.040	2.0472	52	.010	.25	.120	3	42.7	19.4	57000	250000	60000	268000
238K	7.4603	190	.0012	.030	13.3958	340	.0016	.040	2.1854	55	.012	.30	.120	3	50.7	23.0	65000	290000	67000	297000
240K	7.8740	200	.0012	.030	14.1732	360	.0016	.040	2.2235	58	.012	.30	.120	3	58.2	26.4	83000	370000	90000	400000
242K	8.2677	210	.0012	.030	14.9606	380	.0016	.040	2.4016	61	.012	.30	.120	3	71.4	32.4	78500	349000	73500	325000
244K	8.6614	220	.0012	.030	15.7480	400	.0018	.040	2.5591	65	.012	.30	.120	3	81.4	36.9	86500	380000	80000	355000
246K	9.0551	230	.0012	.030	16.5354	420	.0018	.045	2.7772	68	.012	.30	.120	3	90.3	41.8	95000	425000	85000	380000
248K	9.4488	240	.0012	.030	17.3228	440	.0018	.045	2.8348	72	.012	.30	.120	3	103.1	46.8	116000	520000	102000	450000
250K	9.8425	250	.0014	.035	18.1102	460	.0018	.045	2.9921	76	.012	.30	.160	3	122.4	55.6	129000	580000	110000	490000
252K	10.2362	260	.0014	.035	18.8976	480	.0018	.045	3.1496	80	.014	.35	.160	3	139.0	62.9	143000	640000	118000	525000
258K	11.0236	290	.0014	.035	19.6850	500	.0018	.045	3.1496	80	.014	.35	.160	3	141.4	64.1	160000	710000	125000	550000
260K	11.8110	300	.0014	.035	21.2598	540	.0020	.050	3.3465	85	.014	.35	.160	3	192.7	87.1	150000	670000	116000	510000
264K	12.5984	320	.0016	.040	22.8346	580	.0020	.050	3.6220	92	.016	.40	.160	3	208.5	94.1	220000	980000	160000	710000

¹⁾Maximum shaft or housing fillet which bearing cannot fit clear.

ENGINEERING**SHAFT AND HOUSING FITS****RADIAL BALL BEARINGS****SHAFT FITS, ABEC-1, ABEC-3**

NOTE: These tables are to be used for applications where only one ring (either inner or outer) has an interference fit with its shaft or housing. The guidelines for operating conditions covering these tables are found on page E38. In cases where interference fits are used for both rings, bearings with special radial internal clearance may be required. Shaft diameter dimensions are for solid steel shafts. Consult The Torrington Company district office nearest you when using hollow shafts.

These diameters result in shaft to bearing bore fit which closely conforms to J5 listed on pages E28 and E29.

These diameters result in shaft to bearing bore fit which closely conforms to G8 listed on pages E28 and E29.

SHAFT FITS, ABEC-1, ABEC-3

Basic Bearing Number	Bore Tolerance		Shaft Rotating, Load Stationary or Shaft Stationary, Load Rotating								Shaft Stationary, Load Stationary or Shaft Rotating, Load Rotating							
			shaft diameter				mean fit				shaft diameter				mean fit			
	max.	min.	maximum	minimum	ABEC-1	ABEC-3	maximum	minimum	ABEC-1	ABEC-3	maximum	minimum	ABEC-1	ABEC-3	maximum	minimum	ABEC-1	ABEC-3
	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm
8100, 8200, 200, 300, 5200, 5300 SERIES																		
00	.3637	10	.3634	9.992	.3639	10.005	.3638	9.997	.0002	.005	.00015	.004	.3635	9.995	.3631	9.985	.00025	.008
01	.4724	12	.4721	11.992	.4728	12.004	.4723	11.996	.0002	.005	.00015	.004	.4722	11.994	.4717	11.981	.00030	.008
02	.5903	15	.5903	14.992	.5908	15.006	.5905	14.999	.0002	.005	.00015	.004	.5904	14.996	.5899	14.983	.00030	.008
03	.6693	17	.6690	16.992	.6695	17.005	.6692	16.998	.0002	.005	.00015	.004	.6691	16.995	.6686	16.982	.00030	.008
04	.7874	20	.7870	19.990	.7878	20.010	.7875	20.002	.0005	.013	.00035	.009	.7871	19.992	.7868	19.980	.00035	.009
* 05	.9843	25	.9839	24.990	.9848	25.014	.9844	25.004	.0005	.013	.00035	.009	.9840	24.994	.9835	24.981	.00035	.009
06	1.1811	30	1.1807	29.990	1.1816	30.010	1.1812	30.002	.0005	.013	.00035	.009	1.1808	29.992	1.1803	29.980	.00035	.009
07	1.3780	35	1.3775	34.987	1.3785	35.013	1.3781	35.004	.0005	.014	.00045	.011	1.3778	34.991	1.3770	34.978	.00045	.011
08	1.5748	40	1.5743	39.987	1.5753	40.013	1.5749	40.002	.0005	.014	.00045	.011	1.5744	39.990	1.5738	39.975	.00045	.011
09	1.7717	45	1.7712	44.987	1.7722	45.014	1.7718	45.004	.0005	.014	.00045	.011	1.7713	44.991	1.7707	44.976	.00045	.011
10	1.9685	50	1.9680	49.987	1.9690	50.013	1.9686	50.002	.0005	.014	.00045	.011	1.9681	49.990	1.9675	49.974	.00045	.011
11	2.1654	55	2.1648	54.985	2.1660	55.018	2.1655	55.004	.0007	.017	.00055	.014	2.1650	54.991	2.1643	54.973	.00045	.011
12	2.3622	60	2.3616	59.985	2.3628	60.015	2.3623	60.002	.0007	.017	.00055	.014	2.3618	59.990	2.3611	59.972	.00045	.011
13	2.5591	65	2.5585	64.985	2.5597	65.016	2.5592	65.004	.0007	.017	.00055	.014	2.5587	64.991	2.5580	64.973	.00045	.011
14	2.7559	70	2.7553	69.985	2.7565	70.015	2.7560	70.002	.0007	.017	.00055	.014	2.7555	69.990	2.7548	69.972	.00045	.011
16	2.9528	75	2.9522	74.985	2.9534	75.016	2.9529	75.004	.0007	.017	.00055	.014	2.9524	74.991	2.9517	74.973	.00045	.011
18	3.1496	80	3.1490	79.985	3.1502	80.015	3.1497	80.002	.0007	.017	.00055	.014	3.1492	79.990	3.1485	79.972	.00045	.011
17	3.3465	85	3.3457	84.980	3.3472	85.019	3.3466	85.004	.0008	.020	.00065	.017	3.3460	84.988	3.3452	84.969	.00065	.017
18	3.5433	90	3.5425	89.980	3.5440	90.018	3.5434	90.002	.0008	.020	.00065	.017	3.5428	89.987	3.5420	89.967	.00065	.017
19	3.7402	95	3.7394	94.980	3.7409	95.019	3.7403	95.004	.0008	.020	.00065	.017	3.7397	94.988	3.7389	94.968	.00065	.017
20	3.9370	100	3.9362	99.980	3.9377	100.018	3.9371	100.002	.0008	.020	.00065	.017	3.9365	99.987	3.9357	99.967	.00065	.017
21	4.1339	105	4.1331	104.980	4.1346	105.019	4.1340	105.004	.0008	.020	.00065	.017	4.1334	104.988	4.1326	104.968	.00065	.017
22	4.3307	110	4.3299	109.980	4.3314	110.018	4.3308	110.002	.0008	.020	.00065	.017	4.3302	109.987	4.3294	109.967	.00065	.017
EXTRA-LARGE SERIES																		
124, 224, 324	4.7244	120	4.7236	119.980	4.7251	120.018	4.7245	120.002	.0008	.020	.00065	.017	4.7239	119.987	4.7231	119.967	.00065	.017
126, 226, 326	5.1181	130	5.1171	129.975	5.1196	130.020	5.1182	130.002	.0010	.024	.00075	.019	5.1175	129.984	5.1166	129.962	.00065	.014
128, 228, 328	5.5118	140	5.5108	139.975	5.5126	140.020	5.5112	140.002	.0010	.024	.00075	.019	5.5112	139.984	5.5103	139.962	.00065	.014
9130, 130, 230, 330	5.9055	150	5.9045	149.975	5.9063	150.020	5.9058	150.002	.0010	.024	.00075	.019	5.9049	149.984	5.9040	149.962	.00065	.014
9132, 132, 232	6.2992	160	6.2982	159.975	6.3000	160.020	6.2993	160.002	.0010	.024	.00075	.019	6.2986	159.984	6.2977	159.962	.00065	.014
9134, 134, 234	6.6929	170	6.6919	169.975	6.6937	170.020	6.6930	170.002	.0010	.024	.00075	.019	6.6923	169.984	6.6914	169.962	.00065	.014
9136, 136, 236, 336	7.0866	180	7.0856	179.975	7.0874	180.020	7.0867	180.002	.0010	.024	.00075	.019	7.0860	179.984	7.0851	179.962	.00065	.014
9138, 138, 238, 338	7.4803	190	7.4791	189.970	7.4813	190.025	7.4805	190.005	.0012	.030	.00095	.024	7.4797	189.984	7.4788	189.964	.00065	.014
9140, 240, 340	7.8740	200	7.8728	199.969	7.8750	200.025	7.8742	200.005	.0012	.030	—	—	7.8734	199.984	7.8722	199.954	.0008	.015
9142, 242, 342	8.2677	210	8.2665	212.509	8.2697	209.771	8.2678	210.002	.0012	.030	—	—	8.2672	209.987	8.2658	209.951	.0008	.015
9144, 244, 344	8.6614	220	8.6602	219.969	8.6624	220.025	8.6615	220.005	.0012	.030	—	—	8.6608	219.984	8.6596	219.954	.0008	.015
9146, 246	9.0551	230	9.0539	229.969	9.0561	230.025	9.0553	230.005	.0012	.030	—	—	9.0545	230.022	9.0533	229.951	.0008	.015
248, 348	9.4488	240	9.4476	239.969	9.4498	240.025	9.4490	240.005	.0012	.030	—	—	9.4482	239.984	9.4470	239.954	.0008	.015
250	9.8425	250	9.8411	249.964	9.8434	250.020	9.8426	250.005	.0012	.030	—	—	9.8418	250.022	9.8406	249.972	.0008	.015
9152, 252, 352	10.2362	260	10.2348	259.964	10.2373	260.027	10.2364	260.005	.0014	.036	—	—	10.2355	259.982	10.2343	259.951	.0008	.015
9158, 258, 358	11.0236	280	11.0222	279.964	11.0247	280.027	11.0238	280.005	.0014	.036	—	—	11.0229	279.982	11.0217	279.951	.0008	.015
9160, 260	11.8110	300	11.8095	299.964	11.8121	300.027	11.8112	300.005	.0014	.036	—	—	11.8100	299.982	11.8091	299.951	.0008	.015
9164, 264	12.5984	320	12.5970	319.964	12.5996	320.030	12.5986	320.005	.0015	.038	—	—	12.5977	319.982	12.5963	319.948	.0008	.015
9180	15.7480	400	15.7464	399.969	15.7492	400.030	15.7482	400.005	.0015	.038	—	—	15.7473	399.982	15.7459	399.946	.0008	.015

ENGINEERING

SHAFT AND HOUSING FITS

RADIAL BALL BEARINGS

HOUSING FITS, ABEC-1, ABEC-3

NOTE: These tables are to be used for applications where only one ring (either inner or outer) has an interference fit with its shaft or housing. The guidelines for operating conditions covering these tables are found on page E38. In cases where interference fits are used for both rings, bearings with special radial internal clearance may be required.

HOUSING FITS, ABEC-1, ABEC-3					These diameters result in a bearing O.D. to housing bore fit which closely conforms to H8 listed on pages E30 and E31.								These diameters result in a bearing O.D. to housing bore fit which closely conforms to M7 listed on pages E30A and E31A.							
Basic Bearing Number					Housing Stationary, Load Stationary or Housing Rotating, Load Rotating								Housing Rotating, Load Stationary or Housing Stationary, Load Rotating							
Extra Small	Extra Light	Light	Medium	Heavy	Housing Bore, minimum maximum				Mean Fit Loose, ABEC-1 ABEC-3				Housing Bore, minimum maximum				Mean Fit Tight, ABEC-1 ABEC-3			
30, S, F SERIES	9100, 9300 SERIES	200, 7200 SERIES	300, 7300 SERIES	7400 SERIES	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm
33K3, F33K3	—	—	—	—	.3750	9.525	.3754	9.535	.00040	.010	.00035	.009	.3749	9.507	.3750	9.525	.00015	.004	.00020	.005
33K4	—	—	—	—	.5000	12.700	.5004	12.710	.00040	.010	.00035	.009	.4993	12.682	.5000	12.700	.00015	.004	.00020	.005
33K5, F33K5	—	—	—	—	.5000	12.700	.5004	12.710	.00040	.010	.00035	.009	.4993	12.682	.5000	12.700	.00015	.004	.00020	.005
34K	—	—	—	—	.6259	15.999	.6303	16.010	.00040	.010	.00035	.009	.6252	15.982	.6259	15.999	.00015	.004	.00020	.005
35K	—	—	—	—	.7480	18.999	.7485	19.012	.00045	.011	.00040	.010	.7472	18.979	.7480	18.999	.00020	.005	.00025	.006
36K	—	—	—	—	.7480	18.999	.7485	19.012	.00045	.011	.00040	.010	.7472	18.979	.7480	18.999	.00020	.005	.00025	.006
37K	—	—	—	—	.8661	21.999	.8668	22.012	.00045	.011	.00040	.010	.8653	21.979	.8661	21.999	.00020	.005	.00025	.006
38K	—	—	—	—	.8661	21.999	.8668	22.012	.00045	.011	.00040	.010	.8653	21.979	.8661	21.999	.00020	.005	.00025	.006
38KV	—	—	—	—	.9449	24.000	.9454	24.013	.00045	.011	.00040	.010	.9441	23.980	.9449	24.000	.00020	.005	.00025	.006
39K	9100	—	—	—	1.0236	25.999	1.0241	26.012	.00045	.011	.00040	.010	1.0228	25.979	1.0236	25.999	.00020	.005	.00025	.006
51K7, F51K7	—	—	—	—	.6250	15.875	.6254	15.885	.00040	.010	.00035	.009	.6243	15.857	.6250	15.875	.00015	.004	.00020	.005
51K	—	—	—	—	.7500	19.050	.7505	19.063	.00045	.011	.00040	.010	.7492	19.030	.7500	19.050	.00020	.005	.00025	.006
53K, F53K	—	—	—	—	.8750	22.225	.8755	22.238	.00045	.011	.00040	.010	.8742	22.205	.8750	22.225	.00020	.005	.00025	.006
55K	—	—	—	—	1.1250	28.575	1.1255	28.588	.00045	.011	.00040	.010	1.1242	28.555	1.1250	28.575	.00020	.005	.00025	.006
57K	—	—	—	—	1.3750	34.925	1.3758	34.940	.00055	.014	.00045	.011	1.3740	34.900	1.3750	34.925	.00025	.006	.00035	.009
58K	—	—	—	—	1.6250	41.275	1.6256	41.290	.00055	.014	.00045	.011	1.6240	41.250	1.6250	41.275	.00025	.006	.00035	.009
59K	—	—	—	—	1.8750	47.625	1.8756	47.640	.00065	.014	.00045	.011	1.8740	47.600	1.8750	47.625	.00025	.006	.00035	.009
910K	—	—	—	—	2.0000	50.800	2.0007	50.814	.00060	.015	.00055	.014	1.9993	50.770	2.0000	50.800	.00035	.009	.00040	.010
911K	—	—	—	—	2.1250	53.975	2.1257	53.993	.00060	.015	.00055	.014	2.1238	53.945	2.1250	53.975	.00035	.009	.00040	.010
912K	—	—	—	—	2.2500	57.150	2.2507	57.168	.00060	.015	.00055	.014	2.2493	57.120	2.2500	57.150	.00035	.009	.00040	.010
F2002	—	—	—	—	.3750	9.525	.3753	9.533	.00000	.000	.00000	.000	.3749	9.522	.3753	9.533	.00000	.000	.00000	.000
F2	—	—	—	—	.4375	11.112	.4378	11.120	.00000	.000	.00000	.000	.4374	11.110	.4378	11.120	.00000	.000	.00000	.000
F3	—	—	—	—	.5624	14.265	.5628	14.295	.00000	.000	.00000	.000	.5624	14.265	.5628	14.295	.00000	.000	.00000	.000
F4	—	—	—	—	.6249	15.872	.6253	15.883	.00000	.000	.00000	.000	.6249	15.872	.6253	15.883	.00000	.000	.00000	.000
F5	—	—	—	—	.6874	17.460	.6878	17.470	.00000	.000	.00000	.000	.6874	17.460	.6878	17.470	.00000	.000	.00000	.000
—	9101, 9302	—	—	—	1.1024	28.001	1.1029	28.014	.00045	.011	.00040	.010	1.1018	27.981	1.1024	28.001	.00020	.005	.00025	.006
—	9303	200	—	—	1.1811	30.000	1.1816	30.013	.00045	.011	.00040	.010	1.1803	29.980	1.1811	30.000	.00020	.005	.00025	.006
—	9102	201	—	—	1.2588	31.999	1.2594	32.014	.00055	.014	.00045	.011	1.2588	31.974	1.2594	31.999	.00025	.006	.00035	.009
—	9103	202	300	—	1.3780	35.001	1.3786	35.016	.00055	.014	.00045	.011	1.3770	34.976	1.3780	35.001	.00025	.006	.00035	.009
—	9304	—	301	—	1.4567	37.000	1.4573	37.015	.00055	.014	.00045	.011	1.4557	36.975	1.4567	37.000	.00025	.006	.00035	.009
—	—	203	—	—	1.5748	40.000	1.5754	40.015	.00055	.014	.00045	.011	1.5738	39.975	1.5748	40.000	.00025	.006	.00035	.009
—	9104, 9305	—	302	—	1.8533	46.999	1.8541	47.014	.00055	.014	.00045	.011	1.8525	46.974	1.8533	46.999	.00025	.006	.00035	.009
—	9105, 9306	204	303	—	1.8504	47.000	1.8510	47.015	.00055	.014	.00045	.011	1.8494	46.975	1.8504	47.000	.00025	.006	.00035	.009
* —	—	205	304	—	2.0472	51.999	2.0479	52.017	.00060	.015	.00055	.014	2.0460	51.969	2.0472	51.999	.00035	.009	.00040	.010
—	9106, 9307	—	—	—	2.1654	55.001	2.1661	55.019	.00060	.015	.00055	.014	2.1642	54.971	2.1654	55.001	.00035	.009	.00040	.010
—	9107, 9308	206	305	403	2.4409	61.999	2.4416	62.017	.0006	.015	.00055	.014	2.4397	61.968	2.4409	61.999	.0003	.009	.00040	.010
—	9108	—	—	—	2.6772	68.001	2.6779	68.019	.0006	.015	.00055	.014	2.6760	67.970	2.6772	68.001	.0003	.009	.00040	.010
—	9310	207	306	404	2.8346	71.999	2.8353	72.017	.0006	.015	.00055	.014	2.8334	71.968	2.8346	71.999	.0003	.009	.00040	.010
—	9109	—	—	—	2.9528	75.001	2.9535	75.019	.0006	.015	.00055	.014	2.9516	74.971	2.9528	75.001	.0003	.009	.00040	.010
—	9110	208	307	405	3.1436	80.000	3.1503	80.019	.0006	.015	.00055	.014	3.1484	79.969	3.1436	80.000	.0003	.009	.00040	.010
—	9312	209	—	—	3.3465	85.001	3.3474	85.024	.0008	.019	.00065	.017	3.3451	84.966	3.3465	85.001	.0004	.010	.00050	.013
—	9111	210	308	406	3.5433	90.000	3.5442	90.023	.0008	.019	.00065	.017	3.5419	89.964	3.5433	90.000	.0004	.010	.00050	.013
—	9112	—	—	—	3.7402	95.001	3.7411	120.024	.0008	.019	.00065	.017	3.7388	94.965	3.7402	95.001	.0004	.010	.00050	.013
—	9113	211	309	407	3.9370	100.000	3.9379	100.023	.0008	.019	.00065	.017	3.9356	99.964	3.9370	100.000	.0004	.010	.00050	.013
—	9114	212	310	408	4.3307	110.000	4.3316	110.023	.0008	.019	.00065	.017	4.3293	109.964	4.3307	110.000	.0004	.010	.00050	.013