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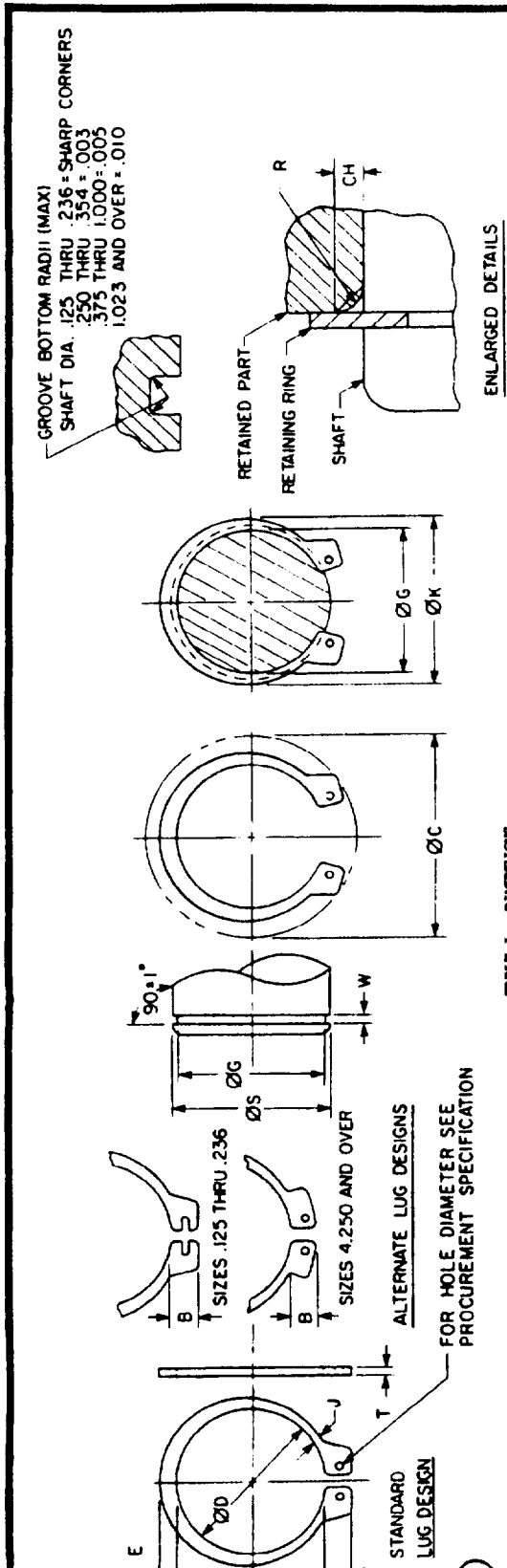


TABLE 1. DIMENSIONS

Ø S SHAFT (REF)	Ø D RING	B LUG HEIGHT	E LARGE SECTION HEIGHT		J SMALL SECTION HEIGHT		THICKNESS		Ø G RECOMMENDED GROOVE		W WIDTH (REF)		Ø K Ø C CLEAR		R Ø C OF RETAINED PART (REF)	
			BASIC	TOL	BASIC	TOL	BASIC	TOL	BASIC	TOL	BASIC	TOL	BASIC	TOL	MAX	MAX
.125	.112	.046	.018	±.0015	.011	±.0015	.010	±.001	.117	.012	.012	.002	.148	.222	.010	.006
.156	.142	.054	.026	.016	.016	.016	.010	.010	.146	.012	.012	.002	.189	.270	.015	.009
.188	.168	.050	.025	.016	.016	.016	.015	.015	.175	±.0015	.018	±.000	.218	.298	.014	.008
.197	.179	.056	.026	±.002	.016	±.002	.015	.015	.185	.0015	.018		.229	.319	.014	.009
.219	.196	.056	.028	.017	.017	.017	.015	.015	.205	FIM 2/	.018		.252	.338	.015	.009
.236	.215	.056	.030	.019	.019	.019	.015	.015	.222	FIM 2/	.018		.272	.355	.016	.010
.250	.225	.080	.035	.025	.025	.025	.025	.025	.230	.030	.030		.290	.450	.018	.011
.276	.250	.081	.035	.024	.024	.024	.025	.025	.255	.030	.030		.315	.480	.017	.010
.281	.256	.080	.038	.025	.025	.025	.025	.025	.261	.030	.030		.326	.490	.020	.012
.312	.281	.087	.040	.026	.026	.026	.025	.025	.290	.030	.030		.357	.540	.020	.012
.344	.309	.087	.042	.026	.026	.026	.025	.025	.321	.030	.030		.390	.570	.021	.012
.354	.320	.087	.046	.029	.029	.029	.025	±.002	.330	.030	.030		.405	.590	.023	.014
.375	.338	.088	.050	.030	.030	.030	.025	.025	.352	.030	.030		.433	.610	.026	.015
.394	.354	.087	.052	.031	.031	.031	.025	.025	.369	FIM 2/	.030	±.003	.452	.620	.027	.016
.406	.366	.087	.054	.033	.033	.033	.025	.025	.382	FIM 2/	.030	±.000	.468	.630	.028	.017
.438	.395	.088	.055	.033	.033	.033	.025	.025	.412	.030	.030		.501	.660	.029	.017
.469	.428	.086	.060	.035	.035	.035	.025	.025	.443	.030	.030		.540	.680	.031	.018
.500	.461	.108	.065	.040	.040	.040	.035	.035	.468	±.002	.040		.574	.770	.034	.020
.551	.509	.108	.053	.036	.036	.036	.035	.035	.519	.004	.040		.611	.810	.027	.016
.562	.521	.108	.072	.041	.041	.041	.035	.035	.530	FIM 2/	.040		.644	.820	.038	.023
.594	.550	.109	.076	.043	.043	.043	.035	.035	.559	FIM 2/	.040		.680	.860	.039	.023
.625	.579	.110	.080	.045	.045	.045	.035	.035	.588	±.003	.040		.715	.900	.041	.025
.669	.621	.110	.082	.043	.043	.043	.035	.035	.629	.004	.040		.756	.930	.040	.024
.672	.621	.110	.082	.043	.043	.043	.035	.035	.631	FIM 2/	.040		.758	.930	.040	.024

ENTIRE STANDARD REVISED

PA NAVY - OS Other Cost ARMY - AR AIR FORCE - 99	INTERNATIONAL INTEREST	TITLE RING, RETAINING, EXTERNAL, BASIC (TAPERED SECTION TYPE)	MILITARY STANDARD MS16624
PROCUREMENT SPECIFICATION MIL - R - 21248	SUPERSEDES MS9012 (ASG) AND MS9013 (ASG)	PAGE 1	OF 9

APPROVED 11 DEC 1958 REVISED (A) 24 JUNE 1969 (B) 6 NOV 1984 (C) 18 APRIL 1990

FED. SUP. CLASS
5365

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FED SUP CLASS
 5365

TABLE 1. DIMENSIONS - CONTINUED

Ø S SHAFT (REF)	Ø D FREE	B LUG HEIGHT		E LARGE SECTION HEIGHT		J SMALL SECTION HEIGHT		THICKNESS		Ø G RECOMMENDED GROOVE (REF)		W WIDTH GROOVE (REF)		Ø K Ø		Ø C Ø CLEAR		R R OF RETAINED PART (REF)	
		BASIC	TOL	BASIC	TOL	BASIC	TOL	BASIC	TOL	BASIC	TOL	BASIC	TOL	BASIC	TOL	BASIC	TOL	BASIC	TOL
1.688	17.5	.136		.084		.048		.042		.646		.047		.779		1.010		.042	
.750	19.0	.136		.092		.051		.042		.704		.047		.850		1.090		.046	
.781	19.8	.136		.094		.052		.042		.733		.047		.883		1.120		.047	
.812	20.6	.136		.096		.054		.042		.762		.047		.914		1.150		.047	
.875	22.2	.137		.104		.057		.042		.821		.047		.987		1.210		.051	
.938	23.8	.166		.110		.063		.042		.882		.047		1.054		1.340		.055	
.984	25.0	.167		.114		.064		.042		.926		.047		1.106		1.390		.056	
1.000	25.4	.167		.116		.065		.042		.940		.047		1.122		1.410		.057	
1.023	26.0	.168		.118		.066		.042		.961		.047		1.147		1.430		.058	
1.062	27.0	.181		.122		.069		.050		.998		.056		1.192		1.500		.060	
1.125	28.6	.182		.128		.071		.050		1.059		.056		1.261		1.550		.063	
1.188	30.2	.182		.132		.072		.050		1.118		.056		1.325		1.610		.064	
1.250	31.7	.183		.140		.076		.050		1.176		.056		1.396		1.690		.068	
1.312	33.3	.183		.146		.076		.050		1.232		.056		1.458		1.750		.068	
1.375	34.9	.184		.152		.082		.050		1.291		.056		1.529		1.800		.072	
1.438	36.5	.184		.160		.086		.050		1.350		.056		1.600		1.870		.076	
1.500	38.1	.214		.168		.091		.050		1.406		.056		1.668		1.990		.079	
1.562	39.7	.235		.172		.093		.062		1.468		.068		1.740		2.100		.082	
1.625	41.3	.235		.180		.097		.062		1.529		.068		1.812		2.170		.087	
1.688	42.9	.235		.184		.099		.062		1.589		.068		1.877		2.240		.090	
1.750	44.4	.237		.188		.101		.062		1.650		.068		1.945		2.310		.091	
1.772	45.0	.237		.190		.102		.062		1.669		.068		1.967		2.330		.092	
1.812	46.0	.238		.192		.102		.062		1.708		.068		2.010		2.383		.092	
1.875	47.6	.239		.196		.104		.062		1.769		.068		2.076		2.440		.094	
1.969	50.0	.245		.200		.106		.062		1.857		.068		2.170		2.540		.094	
2.000	50.8	.239		.204		.108		.062		1.886		.068		2.205		2.550		.096	
2.062	52.4	.266		.208		.111		.078		1.946		.086		2.275		2.680		.098	
2.125	54.0	.266		.212		.113		.078		2.003		.086		2.337		2.750		.098	
2.156	54.8	.266		.212		.113		.078		2.032		.086		2.367		2.780		.097	
2.250	57.1	.267		.220		.116		.078		2.120		.086		2.466		2.870		.100	
2.312	58.7	.267		.222		.118		.078		2.178		.086		2.528		2.940		.100	
2.375	60.3	.267		.224		.119		.078		2.239		.086		2.591		3.010		.100	
2.438	61.9	.268		.228		.120		.078		2.299		.086		2.657		3.070		.102	
2.500	63.5	.268		.232		.122		.078		2.360		.086		2.724		3.120		.104	
2.559	65.0	.268		.238		.125		.078		2.419		.086		2.792		3.180		.108	
2.625	66.7	.268		.242		.127		.078		2.481		.086		2.860		3.250		.109	
2.688	68.3	.268		.246		.129		.078		2.541		.086		2.926		3.320		.111	
2.750	69.8	.310		.248		.131		.093		2.602		.103		2.992		3.450		.112	
2.875	73.0	.308		.256		.133		.093		2.721		.103		3.122		3.570		.115	

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PA NAVY - OS Other Cust	INTERNATIONAL INTEREST	TITLE RING, RETAINING, EXTERNAL, BASIC (TAPERED SECTION TYPE)	MILITARY STANDARD MS16624
PROCUREMENT SPECIFICATION MIL-R-21248	SUPERSEDES MS9012 (ASG) AND MS9013 (ASG)	PAGE 2	OF 9

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TABLE I. DIMENSIONS - CONTINUED

Ø S SHAFT (REF)	Ø D FREE	B LOG HEIGHT		E LARGE SECTION HEIGHT		J SMALL SECTION HEIGHT		THICKNESS		Ø G RECOMMENDED GROOVE (REF)		W WIDTH GROOVE (REF)		Ø K 3/ CLEAR	R 5/ OF RETAINED PART (REF)	Ø H 5/ MAX
		BASIC	TOL	BASIC	TOL	BASIC	TOL	BASIC	TOL	BASIC	TOL	BASIC	TOL			
2.938	2.717	.308	±.007	.260	±.007	.136	±.007	.093		2.779		.103		3.640	.116	.070
3.000	2.775	.308		.264		.138		.093		2.838		.103		3.690	.117	.070
3.062	2.832	.298		.252		.131		.093		2.898		.103		3.740	.107	.064
3.125	2.892	.308		.272		.141		.093		2.957		.103		3.820	.120	.072
3.156	2.920	.308		.274		.143		.093		2.986		.103		3.850	.120	.072
3.250	3.006	.308	±.005	.280	±.008	.145		.093		3.076		.103		3.950	.123	.074
3.346	3.092	.308		.286		.147		.093		3.166		.103		4.040	.126	.076
3.438	3.179	.308		.292		.148		.093		3.257		.103		4.140	.129	.077
3.500	3.237	.328		.285		.148	±.008	.109		3.316		.120		4.250	.122	.073
3.543	3.277	.328		.288		.149		.109	±.003	3.357		.120	±.005	4.290	.123	.074
3.625	3.352	.328		.296		.153		.109		3.435	±.006 2/ FIM 2/	.120	-0.000	4.370	.127	.076
3.688	3.410	.330		.302		.156		.109		3.493		.120		4.430	.129	.078
3.750	3.468	.332		.310		.160		.109		3.552		.120		4.500	.133	.080
3.875	3.584	.330		.318		.163		.109		3.673		.120		4.600	.137	.082
3.938	3.642	.342		.318		.163		.109		3.734		.120		4.700	.137	.082
4.000	3.700	.352		.318		.166		.109		3.792		.120		4.780	.135	.081
4.250	3.989	.395		.318		.176		.109		4.065		.120		5.090	.146	.088
4.375	4.106	.395		.318		.181		.109		4.190		.120		5.220	.146	.088
4.500	4.223	.404		.285		.128		.109		4.310		.120		5.370	.102	.061
4.750	4.458	.429		.303		.136		.109		4.550		.120		5.670	.115	.069
5.000	4.692	.450	±.008	.360	±.010	.194		.109		4.790		.120		5.960	.165	.099
5.250	4.927	.472		.372		.211		.125		5.030		.139	±.006	6.270	.169	.101
5.500	5.162	.497		.390		.209		.125	±.004	5.265		.139	-0.000	6.570	.175	.105
5.750	5.396	.518		.408		.220		.125		5.505		.139		6.860	.184	.110
6.000	5.631	.540		.381		.171		.125		5.745		.139		7.160	.143	.086
6.250	5.866	.561		.396		.176		.156		5.985		.174		7.460	.148	.089
6.500	6.100	.586		.438		.236		.156		6.225		.174		7.870	.191	.114
6.750	6.335	.608		.456		.246		.156		6.465		.174	±.008	8.060	.200	.120
7.000	6.570	.530		.474		.256		.156		6.705		.174	-0.000	8.360	.208	.125
7.500	7.009	.676	±.012	.507	±.015	.277		.187	±.005	7.180		.209		8.960	.220	.132
8.000	7.478	.735		.540		.294		.187		7.660		.209		9.600	.235	.141
8.500	7.947	.735		.573		.314		.187		8.140		.209		10.100	.250	.150
9.000	8.415	.735		.609		.333		.187		8.620		.209		10.600	.267	.160
9.500	8.885	.735		.642		.350		.187		9.100		.209		11.100	.281	.168
10.000	9.355	.735		.675		.367		.187		9.575		.209		11.600	.294	.176

FOR FOOTNOTES SEE PAGE 4

PA NAVY - OS Other Cust ARMY - AR AIR FORCE - 99	INTERNATIONAL INTEREST	TITLE RING, RETAINING, EXTERNAL, BASIC (TAPERED SECTION TYPE)	MILITARY STANDARD MS16624
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- 1/ T - THICKNESS "T" APPLIES TO UNPLATED RINGS. FOR CORROSION RESISTANT STEEL AND PLATED RINGS, +.002 SHOULD BE ADDED TO THE MAXIMUM TOLERANCE, I.E. $\pm .002$ SHOULD BE $\pm .004/- .002$.
- 2/ FIM - (FULL INDICATOR MOVEMENT) IS THE MAXIMUM ALLOWABLE DEVIATION OF CONCENTRICITY BETWEEN THE GROOVE AND THE SHAFT.
- 3/ K - MAXIMUM DIAMETER WHEN THE RING IS PROPERLY SEATED IN THE GROOVE. (DESIGN REFERENCE DIMENSION).
- 4/ C - ACTUAL CLEARANCE DIAMETER WHEN THE RING IS SPRUNG OVER THE SHAFT PRIOR TO INSTALLATION INTO THE GROOVE. (DESIGN REFERENCE DIMENSION).
- 5/ R AND CH - RADII OR CHAMFERS ALLOWABLE ON PARTS TO BE RETAINED BY THE RINGS. ALLOWABLE THRUST LOADS FOR RINGS RETAINING PARTS WITH MAXIMUM CORNER RADII OR CHAMFERS ARE LISTED IN TABLE VII ON PAGE 9.

REQUIREMENTS:

1. **CLASSIFICATION:** RETAINING RINGS FURNISHED UNDER THIS STANDARD SHALL BE TYPE 1, CLASS 2 OF THE PROCUREMENT SPECIFICATION.
2. **MATERIAL:** CARBON SPRING STEEL, GRADE 1060 THRU 1095 (UNS G10600 THRU G10950) IN ACCORDANCE WITH ASTM A 568 OR ASTM A 682.
CORROSION RESISTANT STEEL, IN ACCORDANCE WITH AMS 5520 (UNS S15700).
BERYLLIUM COPPER, ALLOY NUMBER 170 (UNS C17000) OR ALLOY NUMBER 172 (UNS C17200) IN ACCORDANCE WITH ASTM B 194.
3. **HARDNESS:**

TABLE II. HARDNESS

Ø SHAFT (REF)	CARBON STEEL	CORROSION RESISTANT STEEL	BERYLLIUM COPPER
.125 TO .236 .250 TO .669 .688 TO 1.500 1.562 TO 3.437 3.500 & ABOVE	68.5-73.0 HR30N 52.5-59.0 HR45N 46.0-51.0 HRC 44.0-49.0 HRC		77 TO 82 HR15N
.250 TO .812 .875 & ABOVE .250 TO 1.023 1.062 & ABOVE		63-69.5 HR30N 44-51 HRC	56.5 TO 62 HR30N 37 TO 43 HRC

4. **PROTECTIVE FINISH OR SURFACE TREATMENT:**
 - a. CARBON STEEL - SHALL BE (SEE TABLE III, IV OR V):
 1. CADMIUM PLATE IN ACCORDANCE WITH QQ-P-416, TYPE II, CLASS 3 OR ASTM B 696, TYPE II, CLASS 5.
 2. ZINC COAT IN ACCORDANCE WITH ASTM B633, TYPE II, CLASS Fe/Zn 5 OR ASTM B 695, TYPE II, CLASS 5.
 3. PHOSPHATE COAT IN ACCORDANCE WITH DOD-P-16232, TYPE 2, CLASS 2.
 - b. CORROSION RESISTANT STEEL - SHALL BE CLEANED, DESCALED AND PASSIVATED IN ACCORDANCE WITH QQ-P-35.
 - c. BERYLLIUM COPPER - CADMIUM PLATE IN ACCORDANCE WITH QQ-P-416, TYPE II, CLASS 3 OR ASTM B 696, TYPE II, CLASS 5.
5. **PART NUMBER:** THE BASIC MS PART NUMBER IS FOLLOWED BY A DASH NUMBER TAKEN FROM TABLE III, IV OR V.

EXAMPLE: MS16624-1100 IS THE PART NUMBER FOR A CARBON STEEL CADMIUM PLATE, EXTERNAL BASIC RETAINING RING FOR USE ON A 1.000 SHAFT DIAMETER.

NOTES:

1. UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN INCHES.
2. IN THE EVENT OF A CONFLICT BETWEEN THE TEXT OF THIS STANDARD AND THE REFERENCES CITED HEREIN, THE TEXT OF THIS STANDARD SHALL TAKE PRECEDENCE.
3. REFERENCED GOVERNMENT (OR NON-GOVERNMENT) DOCUMENTS OF THE ISSUE LISTED IN THAT ISSUE OF THE DEPARTMENT OF DEFENSE INDEX OF SPECIFICATIONS AND STANDARDS (DODISS) SPECIFIED IN THE SOLICITATION FORM A PART OF THIS STANDARD TO THE EXTENT SPECIFIED HEREIN.

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PA NAVY - OS Other Cust ARMY - AR AIR FORCE - 99	INTERNATIONAL INTEREST	TITLE RING, RETAINING, EXTERNAL, BASIC (TAPERED SECTION TYPE)	MILITARY STANDARD	
			MS16624	
PROCUREMENT SPECIFICATION MIL-R-21248	SUPERSEDES MS9012 (ASG) AND MS9013 (ASG)	PAGE 4	OF 9	

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ARMY - AI

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TABLE III. DASH NUMBERS FOR MS16624

Ø S SHAFT (REF)	CARBON STEEL CND PLATE	CARBON STEEL ZINC COAT	CARBON STEEL ZINC COAT PROSPRINATE COAT	CRES	Be COPPER CND PLATE	Be COPPER CND PLATE	Be COPPER CND PLATE	Ø S SHAFT (REF)	CARBON STEEL CND PLATE	CARBON STEEL ZINC COAT	CARBON STEEL ZINC COAT PROSPRINATE COAT	CRES	Be COPPER CND PLATE	Be COPPER CND PLATE	Ø S SHAFT (REF)	CARBON STEEL CND PLATE	CARBON STEEL ZINC COAT	CARBON STEEL ZINC COAT PROSPRINATE COAT	CRES	DASH NO
1.75	1025	2025	3025	4025	5025	6025	7025	1.062	1206	2106	3106	4106	5106	6106	1.125	1312	2312	3312	4312	4312
1.56	1027	2027	3027	4027	5027	6027	7027	1.125	1212	2112	3112	4112	5112	6112	1.156	1315	2315	3315	4315	4315
1.88	1028	2028	3028	4028	5028	6028	7028	1.188	1118	2118	3118	4118	5118	6118	1.250	1325	2325	3325	4325	4325
1.97	1029	2029	3029	4029	5029	6029	7029	1.250	1125	2125	3125	4125	5125	6125	1.346	1334	2334	3334	4334	4334
2.14	1031	2031	3031	4031	5031	6031	7031	1.312	1131	2131	3131	4131	5131	6131	1.346	1334	2334	3334	4334	4334
2.50	1032	2032	3032	4032	5032	6032	7032	1.375	1137	2137	3137	4137	5137	6137	1.500	1350	2350	3350	4350	4350
2.76	1033	2033	3033	4033	5033	6033	7033	1.438	1143	2143	3143	4143	5143	6143	1.543	1354	2354	3354	4354	4354
3.12	1034	2034	3034	4034	5034	6034	7034	1.500	1150	2150	3150	4150	5150	6150	1.625	1362	2362	3362	4362	4362
3.54	1035	2035	3035	4035	5035	6035	7035	1.562	1156	2156	3156	4156	5156	6156	1.688	1368	2368	3368	4368	4368
3.75	1037	2037	3037	4037	5037	6037	7037	1.625	1162	2162	3162	4162	5162	6162	1.750	1375	2375	3375	4375	4375
3.94	1038	2038	3038	4038	5038	6038	7038	1.688	1168	2168	3168	4168	5168	6168	1.875	1387	2387	3387	4387	4387
4.06	1040	2040	3040	4040	5040	6040	7040	1.750	1175	2175	3175	4175	5175	6175	1.938	1393	2393	3393	4393	4393
4.38	1043	2043	3043	4043	5043	6043	7043	1.772	1177	2177	3177	4177	5177	6177	2.000	1400	2400	3400	4400	4400
4.69	1046	2046	3046	4046	5046	6046	7046	1.812	1181	2181	3181	4181	5181	6181	2.000	1400	2400	3400	4400	4400
5.00	1050	2050	3050	4050	5050	6050	7050	1.875	1187	2187	3187	4187	5187	6187	2.125	1425	2425	3425	4425	4425
5.51	1055	2055	3055	4055	5055	6055	7055	1.969	1196	2196	3196	4196	5196	6196	2.125	1425	2425	3425	4425	4425
5.62	1056	2056	3056	4056	5056	6056	7056	2.000	1200	2200	3200	4200	5200	6200	2.250	1450	2450	3450	4450	4450
5.94	1059	2059	3059	4059	5059	6059	7059	2.062	1206	2206	3206	4206	5206	6206	2.250	1450	2450	3450	4450	4450
6.25	1062	2062	3062	4062	5062	6062	7062	2.125	1212	2212	3212	4212	5212	6212	2.375	1475	2475	3475	4475	4475
6.69	1066	2066	3066	4066	5066	6066	7066	2.156	1215	2215	3215	4215	5215	6215	2.500	1500	2500	3500	4500	4500
6.72	1067	2067	3067	4067	5067	6067	7067	2.250	1225	2225	3225	4225	5225	6225	2.500	1500	2500	3500	4500	4500
6.88	1068	2068	3068	4068	5068	6068	7068	2.312	1231	2231	3231	4231	5231	6231	2.500	1500	2500	3500	4500	4500
7.50	1075	2075	3075	4075	5075	6075	7075	2.375	1237	2237	3237	4237	5237	6237	2.625	1525	2625	3625	4625	4625
7.81	1078	2078	3078	4078	5078	6078	7078	2.438	1243	2243	3243	4243	5243	6243	2.625	1525	2625	3625	4625	4625
8.12	1081	2081	3081	4081	5081	6081	7081	2.475	1247	2247	3247	4247	5247	6247	2.750	1575	2750	3750	4750	4750
8.75	1087	2087	3087	4087	5087	6087	7087	2.625	1262	2262	3262	4262	5262	6262	2.750	1575	2750	3750	4750	4750
9.38	1093	2093	3093	4093	5093	6093	7093	2.688	1268	2268	3268	4268	5268	6268	2.875	1587	2875	3875	4875	4875
9.64	1096	2096	3096	4096	5096	6096	7096	2.750	1275	2275	3275	4275	5275	6275	2.875	1587	2875	3875	4875	4875
1.000	1100	2100	3100	4100	5100	6100	7100	2.875	1287	2287	3287	4287	5287	6287	2.938	1593	2938	3938	4938	4938
1.023	1102	2102	3102	4102	5102	6102	7102	2.938	1293	2293	3293	4293	5293	6293	3.062	1606	3062	4062	5062	5062

1/ SUBSTITUTE CONNECTION MECHANISM STEEL WELD USED IN FOOD PROCESSING MACHINERY, OR IN PUMP OR FABRICATION SYSTEMS, OR WELD USED AT TEMPERATURES OVER 50°F (10°C).

PA NAVY - OS Other Cust ARMY - AR AIR FORCE - 99	INTERNATIONAL INTEREST	TITLE RING, RETAINING, EXTERNAL, BASIC (TAPERED SECTION TYPE)	MILITARY STANDARD MS16624
PROCUREMENT SPECIFICATION MIL-R-21248	SUPERSEDES MS9012 (ASG) AND MS9013 (ASG)	PAGE 5	OF 9

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TABLE IV. SUBSTITUTION TABLE CROSS REFERENCE OF PART NUMBERS

D/S SHAFT (REF)	INACTIVE		SUBST		SUBST		D/S SHAFT (REF)	INACTIVE		SUBST		SUBST	
	MS9013	MS16624	MS16624	MS16624	MS16624	MS16624		MS9013	MS16624	MS16624	MS16624	MS16624	MS16624
250	01	25	1025	1025	1125	2125	1,250	30	1,250	1,250	3125	3125	3125
276	02	27	1027	2025	1131	2131	1,312	31	1,312	1,311	2131	3131	3131
281	03	28	1028	2027	1137	2137	1,375	32	1,375	1137	2137	3137	3137
312	04	31	1031	2031	1143	2143	1,438	33	1,438	1143	2143	3143	3143
344	05	34	1034	2034	1150	2150	1,500	34	1,500	1150	2150	3150	3150
374	06	35	1035	2035	1156	2156	1,562	35	1,562	1156	2156	3156	3156
375	07	37	1037	2037	1162	2162	1,625	36	1,625	1162	2162	3162	3162
394	08	39	1039	2039	1168	2168	1,688	37	1,688	1168	2168	3168	3168
406	09	40	1040	2040	1175	2175	1,750	38	1,750	1175	2175	3175	3175
438	10	43	1043	2043	1177	2177	1,772	39	1,772	1177	2177	3177	3177
469	11	46	1046	2046	1181	2181	1,812	40	1,812	1181	2181	3181	3181
500	12	50	1050	2050	1187	2187	1,875	41	1,875	1187	2187	3187	3187
531	13	55	1055	2055	1196	2196	1,969	42	1,969	1196	2196	3196	3196
562	14	56	1056	2056	1200	2200	2,000	43	2,000	1200	2200	3200	3200
594	15	59	1059	2059	1206	2206	2,062	44	2,062	1206	2206	3206	3206
625	16	62	1062	2062	1212	2212	2,125	45	2,125	1212	2212	3212	3212
669	17	64	1064	2064	1215	2215	2,156	46	2,156	1215	2215	3215	3215
672	18	67	1067	2067	1225	2225	2,250	47	2,250	1225	2225	3225	3225
688	19	68	1068	2068	1231	2231	2,312	48	2,312	1231	2231	3231	3231
750	20	75	1075	2075	1237	2237	2,375	49	2,375	1237	2237	3237	3237
781	21	78	1078	2078	1243	2243	2,438	50	2,438	1243	2243	3243	3243
812	22	81	1081	2081	1250	2250	2,500	51	2,500	1250	2250	3250	3250
875	23	87	1087	2087	1255	2255	2,559	52	2,559	1255	2255	3255	3255
938	24	93	1093	2093	1262	2262	2,625	53	2,625	1262	2262	3262	3262
984	25	98	1098	2098	1268	2268	2,688	54	2,688	1268	2268	3268	3268
1,000	26	100	1100	2100	1275	2275	2,750	55	2,750	1275	2275	3275	3275
1,023	27	102	1102	2102	1287	2287	2,875	56	2,875	1287	2287	3287	3287
1,062	28	106	1106	2106	1293	2293	2,938	57	2,938	1293	2293	3293	3293
1,125	29	112	1112	2112	1300	2300	3,000	58	3,000	1300	2300	3300	3300
1,188	30	118	1118	2118	1306	2306	3,062	59	3,062	1306	2306	3306	3306

✓ SUBSTITUTE CONSIDER MS16624 STEEL WHEN USED IN FOOD PROCESSING MACHINERY, OR IN PUMP OR LUBRICATION SYSTEMS, OR WHEN USED AT TEMPERATURES OVER 550°F (233°C).

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TABLE V. SUBSTITUTION TABLE (CROSS REFERENCE OF PART NUMBERS)

Ø s SHAFT (REF)	INACTIVE	INACTIVE	SUBST	Ø s SHAFT (REF)	INACTIVE	SUBST
	BERYLLIUM ✓ COPPER	BERYLLIUM ✓ COPPER	BERYLLIUM ✓ COPPER		BERYLLIUM ✓ COPPER CAD PLATE	BERYLLIUM ✓ COPPER CAD PLATE
	MS9012	MS16624	MS16624		MS16624	MS16624
.125	01	12	5012	.125	1012	5012-1
.156	02	15	5015	.156	1015	5015-1
.188	03	18	5018	.188	1018	5018-1
.197	04	19	5019	.197	1019	5019-1
.219	05	21	5021	.219	1021	5021-1
.236	06	23	5023	.236	1023	5023-1

✓ SUBSTITUTE CORROSION RESISTANT STEEL WHEN USED IN FOOD PROCESSING MACHINERY, OR IN FUEL OR LUBRICATION SYSTEMS, OR WHEN USED AT TEMPERATURES OVER 450°F (233°C).

RECOMMENDED DESIGN LIMITATIONS AND USAGE

(a) INTENDED USE - TO PROVIDE SHOULDERS FOR POSITIONING AND RETAINING MACHINE COMPONENTS ON SHAFTS. TAPERED DESIGN PRINCIPLE PERMITS RINGS TO MAINTAIN PRACTICALLY CONSTANT CIRCULARITY AND PRESSURE AGAINST BOTTOM OF GROOVE, COUNTERACTING CONSIDERABLE CENTRIFUGAL FORCE (SEE TABLE VI). RINGS FOR SHAFT DIAMETERS OVER 4 INCHES ARE SPECIALLY DIMENSIONED TO MAINTAIN BALANCE IN ROTATION. THE USE OF THE FOLLOWING FORMULAS ARE BASED ON THE FACT THAT THE RING WILL NOT FAIL IN COMPRESSION.

LIMITATION ON USE - THE FOLLOWING FORMULAS ARE NOT TO BE USED FOR BRITTLE MATERIALS SUCH AS CAST IRON, ETC.

WARNING - RINGS SHOULD NOT BE OVER EXPANDED DURING INSTALLATION SINCE THIS WILL LEAD TO RING FAILURE. IF RING HAS PLAY BETWEEN THE GROOVE DIAMETER AND THE INSIDE RING DIAMETER THIS INDICATES THAT THE RING HAS BEEN OVER EXPANDED, (PROVIDING GROOVE HAS BEEN MACHINED TO RECOMMENDED DIMENSIONS).

FOR APPROXIMATE SAFETY RPM LIMITS SEE TABLE VI.

TABLE VI. APPROXIMATE SAFETY RPM LIMITS

Ø SHAFT (INCHES)		.125	.500	1	2	3	4	6	8	10
CARBON STEEL AND CORROSION RESISTANT STEEL	RPM LIMIT	80,000	40,000	20,000	10,000	6,700	5,000	3,400	2,500	2,000
BERYLLIUM COPPER	RPM LIMIT	50,000	25,000	13,000	6,400					

(b) ALLOWABLE THRUST LOAD CAPACITY OF THE RINGS. ABUTTING COMPONENTS TO HAVE SHARP CORNERS =

$$P = \frac{\pi S T X}{F}$$

WHERE:

- P = ALLOWABLE THRUST LOAD (POUNDS)
- S = SHAFT DIAMETER (INCHES)
- T = RING THICKNESS (INCHES)
- X = ULTIMATE SHEAR STRENGTH OF THE RING MATERIAL (PSI) ✓
- F = FACTOR OF SAFETY

A SAFETY FACTOR, F = 4, IS RECOMMENDED, SINCE THE RING UNDER LOAD IS SUBJECTED NOT ONLY TO THE PURE SHEAR STRESSES, BUT ALSO TO BENDING STRESSES.

(c) ALLOWABLE LOAD CAPACITY OF GROOVE WALL =

$$P = \frac{\pi S d Y}{F}$$

WHERE:

- P = ALLOWABLE COMPRESSION LOAD (POUNDS)
- S = SHAFT DIAMETER (INCHES)
- d = GROOVE DEPTH (INCHES)
- Y = YIELD STRENGTH IN COMPRESSION OF THE GROOVE MATERIAL (PSI)
- F = FACTOR OF SAFETY

TO INSURE A SAFE WORKING LOAD, A SAFETY FACTOR, F = 2, IS RECOMMENDED.

(d) MINIMUM DISTANCE BETWEEN OUTER GROOVE WALL AND END OF SHAFT =

$$Z = 3d$$

WHERE:

- Z = MINIMUM DISTANCE BETWEEN OUTER GROOVE AND END OF SHAFT (INCHES)
- d = GROOVE DEPTH (INCHES)

- ✓ X = 120,000 PSI ULTIMATE SHEAR STRENGTH FOR RINGS UP TO AND INCLUDING .672 INCH SHAFT DIAMETER OF CARBON STEEL OR CORROSION RESISTANT STEEL.
- X = 150,000 PSI ULTIMATE SHEAR STRENGTH FOR RINGS .688 INCH AND OVER SHAFT DIAMETER OF CARBON STEEL OR CORROSION RESISTANT STEEL.
- X = 110,000 PSI ULTIMATE SHEAR STRENGTH FOR RINGS OF ALL SHAFT DIAMETERS AND OF BERYLLIUM COPPER.

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PROCUREMENT SPECIFICATION MIL-R-21248	SUPERSEDES MS9012 (ASG) AND MS9013 (ASG)	PAGE 7 OF 9	

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(e) DIFFERENTIAL ROTATION =

THE CONDITIONS UNDER WHICH A RETAINING RING MAY BE USED WHEN ADJACENT PARTS ROTATE RELATIVE TO IT, FALL INTO TWO CATEGORIES:

1. WHERE NO THRUST IS EXERTED BY ADJACENT PART; IN THIS CASE, DIFFERENTIAL ROTATION OF RING AND ADJACENT PART CREATES NO ELEMENT OF RISK IN THE APPLICATION OF THE RINGS BECAUSE NO FRICTIONAL TORQUE IS EXERCISED BY THE MACHINE PART ON THE RING.
2. CONSIDERATION MUST BE GIVEN TO THE MAGNITUDE OF THE THRUST INVOLVED. THE FRICTION MOMENT MAY NOT EXCEED THE BENDING MOMENT, WHICH THE RING CAN TOLERATE WITHOUT RELEASING ITS PRESSURE AGAINST THE BOTTOM OF THE GROOVE, FORMULATED AS FOLLOWS:

$$FPN \leq \frac{STE^2}{18}$$

OR

$$P \leq \frac{STE^2}{f18N}$$

WHERE:

- P = ALLOWABLE THRUST LOAD EXERTED BY ADJACENT PART (POUNDS)
- f = COEFFICIENT OF FRICTION
- S = WORKING STRESS OF RING UNDER MAXIMUM EXPANSION (PSI)^{2/}
- T = RING THICKNESS (INCHES)
- E = GREATEST WIDTH SECTION OF RING (INCHES)
- N = NEUTRAL RING DIAMETER (INCHES), FREE DIAMETER PLUS 3/4 E DIMENSION

IN SUCH CASES WHERE DIFFERENTIAL ROTATION OCCURS, THE CALCULATION SHOULD BE BASED ON THE MAXIMUM POSSIBLE VALUE OF THE COEFFICIENT OF FRICTION.

(f) IMPACT CAPACITY OF RING OR GROOVE WALL =

$$I_R = \frac{PT}{2} - \text{FOR THE RING (INCH POUNDS), ABUTTING COMPONENTS TO HAVE SHARP CORNERS.}$$

$$I_G = \frac{Pd}{2} - \text{FOR THE GROOVE (INCH POUNDS)}$$

WHERE:

- P = ALLOWABLE THRUST LOAD OF RINGS OR GROOVES (POUNDS)
- T = RING THICKNESS (INCHES)
- I_G = IMPACT CAPACITY OF GROOVE WALL (INCH POUNDS)
- d = GROOVE DEPTH (INCHES)
- I_R = IMPACT CAPACITY OF RING (INCH POUNDS)

(g) LOAD CAPACITY, WITH THE RETAINED PART RADIUS OR CHAMFERED =

WHEN THE RADIUS OR CHAMFER OF THE RETAINED PART DOES NOT EXCEED THE MAXIMUM RADIUS ALLOWED FOR THE BOTTOM OF THE RING GROOVE, THE LESSER LOAD CAPACITY COMPUTED FROM THE FORMULAS ON PAGES 7 AND 8 WILL APPLY. THE CORNER RADIUS AND CHAMFERS LISTED ON PAGES 1 THRU 3 WERE CHOSEN AS LARGE AS POSSIBLE FOR THE RING SIZES INVOLVED AND ARE RELATED TO THE MAXIMUM THRUST LOADS LISTED IN THE TABLE ON PAGE 9. IF THE CORNER RADIUS OR CHAMFERS ARE SMALLER THAN THOSE LISTED, THEN THE THRUST LOADS INCREASE PROPORTIONALLY, IN ACCORDANCE WITH THE FOLLOWING FORMULAS:

$$P^1 = \frac{P}{CH^1}$$

OR

$$P^1 = \frac{P}{R^1}$$

$$P^1 = \frac{P}{CH^1}$$

WHERE:

- P¹ = NEW ALLOWABLE THRUST LOAD
- P = LISTED ALLOWABLE THRUST LOAD
- CH¹ = NEW (SMALLER) CHAMFER
- CH = LISTED CHAMFER
- R¹ = NEW (SMALLER) CORNER RADIUS
- R = LISTED CORNER RADIUS

^{2/} s = 250,000 PSI WORKING STRESS FOR RINGS OF CARBON STEEL OR CORROSION RESISTANT STEEL
s = 200,000 PSI WORKING STRESS FOR RINGS OF BERYLLIUM COPPER.

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LIMIT LOADS LISTED BELOW ARE BASED ON RINGS OF BERYLLIUM COPPER (WORKING STRESS 180,000 PSI) FOR SIZES BELOW .250 INCH AND ON RINGS OF STEEL (WORKING STRESS 250,000 PSI) FOR SIZES .250 INCH AND OVER. IF THE ALLOWABLE GROOVE CAPACITY LOADS AS CALCULATED BY USING THE FORMULA ON PAGE 7 ARE LESS, THEN THEY SHOULD BE USED.

TABLE VII. LIMIT LOADS.

NOMINAL RING SIZE		ALLOWABLE THRUST LOAD FOR RING ASSEMBLIES WITH PARTS HAVING MAXIMUM CORNER RADIi OR CHAMFERS	
FROM	TO	CARBON STEEL OR CRES	BERYLLIUM COPPER
.125	.156		45 LB
.188	.236		105 LB
.250	.469	470 LB	340 LB
.500	.672	910 LB	650 LB
.688	1.023	1340 LB	950 LB
1.062	1.500	1950 LB	1400 LB
1.562	2.000	3000 LB	2100 LB
2.062	2.688	5000 LB	
2.750	3.438	7350 LB	
3.500	5.000	10500 LB	
5.250	6.000	13500 LB	
6.250	7.000	21000 LB	
7.500	10.000	30000 LB	

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