INTRODUCTION
The bearings described in this section of the catalog have been designed to meet the specific needs of the airframe industry. Most of these bearings conform to military, and national standards current at the time of publication of the catalog.

IDENTIFICATION
The code letters **ATF** denote a sealed airframe track roller bearing with a single row of needle rollers, internal thrust washers, and a crowned O.D.

The code letters **ATL** denote a sealed airframe track roller bearing with two rows of needle rollers, and internal thrust washers.

The code letters **NBF** denote an airframe track roller bearing with a single row of needle rollers.

The code letters **NBL** denote an airframe track roller bearing with two rows of needle rollers.

The code letters **NBC** denote an airframe bearing with a single row of needle rollers. Type **NBC** bearings must be mounted in supporting housings.

The code letters **NCC** denote an airframe bearing with a single row of needles and a drawn shell that must be mounted in supporting housings.

The code letters **NBE** denote a self-aligning airframe needle roller bearing with a single row of needle rollers. The code letters **NBK** denote an airframe bearing similar to type **NBE** but with two rows of needle rollers. Both types **NBE** and **NBK** bearings must be mounted in supporting housings.

The code letters **HRS** denote a stud type airframe track roller bearing with a single row of needle rollers. This bearing can be sealed.

The code letters **HRSC** denote a sealed, stud type airframe track roller bearing with a single row of needle rollers and a crowned O.D.

All of these various types of airframe needle roller bearings meet the requirements of U.S. Military Specification AS39901 and the following military specifications:

<table>
<thead>
<tr>
<th>bearing type</th>
<th>military specification</th>
<th>bearing type</th>
<th>military specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ATF</strong></td>
<td>SAE AS21438</td>
<td><strong>NBC</strong></td>
<td>SAE AS24461</td>
</tr>
<tr>
<td><strong>ATL</strong></td>
<td>SAE AS21439</td>
<td><strong>NBE</strong></td>
<td>SAE AS24463</td>
</tr>
<tr>
<td><strong>NBF</strong></td>
<td>SAE AS24465</td>
<td><strong>NBK</strong></td>
<td>SAE AS24464</td>
</tr>
<tr>
<td><strong>NBL</strong></td>
<td>SAE AS24466</td>
<td><strong>HRS</strong></td>
<td>SAE AS21432</td>
</tr>
<tr>
<td><strong>NCC</strong></td>
<td>SAE AS24462</td>
<td><strong>HRSC</strong></td>
<td>SAE AS21447</td>
</tr>
</tbody>
</table>

RBC airframe needle roller bearings are permanently marked with the bearing designation (which includes the bearing type code) and the military specification number as listed in the tabular pages.

Since these bearings are often supplied prelubricated to meet special requirements, the airframe manufacturer’s parts list or another reliable source should always be consulted when ordering bearings to ensure the correct lubricant is used.

Before selecting specific airframe needle roller bearings, the Engineering Section should be reviewed for detailed information concerning:
- Bearing type
- Material section
- Load ratings/life calculations
- Application criteria

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BEARING TYPE SELECTION

Types ATF and NBF bearings are designed for use as track rollers to withstand heavy rolling loads. If their full radial capacity is to be realized, they should be mounted on high strength bolts. Also, the initial alignment between the bearing centerline and the surface of the track should be very good. To prevent deflections under load that would cause poor load distribution along the length of the rolling elements, the bearing should be straddle-mounted in a rigid housing, and the track should be rigidly supported.

Types ATF and NBF bearings are sometimes cantilever mounted on high strength bolts. In this case, the deflection of the supporting member, the mounting bolt and the track should be balanced as carefully as possible to improve the load distribution. If this cannot be accomplished, the track should be crowned, or preference should be given to the type ATF which has a crowned outer ring.

Types ATL and NBL bearings are intended to carry rolling loads which are greater than those for which types ATF and NBF are designed. Since types ATL and NBL bearings are quite long, it is important to mount them on high strength shafts or bolts. The alignment between the bearing axis and the track is even more critical than with types ATF and NBF. Types ATL and NBL bearings must be straddle-mounted.

Types ATF and ATL bearings have seal/thrust washers which increase the life in case the bearings are infrequently relubricated.

Type NBC bearings are designed primarily to carry heavy static loads, or moderate loads under oscillation or slow rotation. This type of bearing can tolerate incidental thrust loads only through the outer ring when the retaining washers are properly backed up.

Type NBC bearings must be supported by housings and mounted on high strength shafts if their inherent load ratings are to be realized. Initial alignment must be good and operating deflections must be minimized to ensure uniform load distribution along the length of the rolling elements.

Type NCC bearings are designed primarily to carry moderate loads under oscillation or slow rotation. This type of bearing should not be used in applications that require thrust capability. The NCC bearings are the minimal cross-section available in standard airframe needle bearings.

Type NCC bearings must be supported by housings and mounted on high strength shafts if their inherent load ratings are to be realized. Initial alignment must be good and operating deflections must be minimal to ensure uniform load distribution along the length of the rolling elements.

Types NBE and NBK bearings are also used primarily for heavy static loads, and will also handle oscillation or slow rotation. They are designed to accommodate only minor locational thrust loads. Types NBE and NBK bearings, like type NBC, must be supported by housings and mounted on high strength shafts if their inherent load ratings are to be realized.

Types NBE and NBK bearings are of larger cross-section than the type NBC, and, if properly mounted, will tolerate misalignment up to ±5°. They are not designed to self-align under heavy loads. If alignment must be accommodated while the bearings are highly loaded, the torque required to overcome the friction at the spherical surfaces may overload the rolling elements.

Types HRSC and HRS bearings are designed for use as track rollers to carry moderate rolling loads. The bearings have an integral stud, which eliminates the need for a separate mounting bolt.

Types HRSC and HRS are to be cantilever mounted. Under load, the supporting member, the bearing stud, and the track may deflect to produce misalignment between the bearing and the track. These deflections should be carefully balanced to minimize the effective misalignment, and improve the load distribution. Where misalignment is a factor, preference should be given to type HRSC, which has a crowned outer ring.
CONSTRUCTION
All airframe needle roller bearings incorporate materials, protective finishes, and relubrication facilities required for airframe service.

MATERIALS
The outer rings, inner rings, and self-aligning rings are made of high carbon chrome steel, hardened, and precision ground.
Studs are made of bearing quality steel, heat treated to 60 HRC minimum in the raceway area and 36-44 HRC in the shank and thread areas.
The rollers are made of high carbon chrome steel, through hardened, precision ground, and lapped.
The retaining washers are made of high carbon steel, and hardened. The bearing components may also be available in a variety of stainless steels. These specialty steels have been developed for use in extremely corrosive environments and may be available upon request.
The NCC series thin shell is made from low carbon steel that is case hardened. The retaining washers are soft low carbon steel.

RELUBRICATION FEATURES
The inner rings of types ATF, ATL, NBF, NCC, and NBL bearings are provided with relubrication grooves and holes. Relubrication features are omitted from the outer rings since they would be undesirable in track roller bearings or thin shells.
Types HRSC and HRS can be provided with lubrication fittings in the flanged end or threaded end of the stud, or with no relubrication provision.
Grooves are provided in the bore and outside diameters of the larger types NBC, NBE, and NBK bearings with drilled holes leading to the needle roller complement to allow relubrication through the housing or the shaft. The smaller sizes, as noted in the tabular pages, do not have relubrication grooves and holes in their inner rings since the mounting shafts would be considerably weakened by the required drilled lubrication holes.
The right is reserved to change material specifications or to revise designs without notice.

PROTECTIVE FINISHES
Outer rings of types ATF, ATL, NBF, NBL, HRSC, and HRS bearings, which are subjected to heavy rolling loads, may be chrome plated on the exposed surfaces for corrosion protection. The other external surfaces of the bearings, except the inner ring bore, (where applicable) are cadmium or zinc-nickel plated.
Types NBC, NCC, NBE, and NBK bearings are cadmium or zinc-nickel plated on all external surfaces, except the bore of the inner ring.

LOAD RATINGS
The limit load ratings listed in this catalog are the maximum radial loads that can be applied without impairing the subsequent function of the bearing in airframe applications.
The ultimate (static fracture) load ratings are not less than 1.5 times the limit load rating.
For types ATF, ATL, NBF, and NBL bearings, the ultimate load rating assumes an unsupported outer ring. Therefore, the limit load ratings listed on the tabular pages correspond to 2/3 of the limit load ratings of the fully supported bearing, or 4/9 ASC. The ultimate (static fracture) load ratings are not less than 1.5 times the limit load rating (2/3 ASC).
In addition to heavy static radial loads, types ATF, ATL, NBF, and NBL bearings must withstand heavy rolling loads under slow rotation. The capacity as a track roller is the load the bearing will carry as a track roller for an L10 life of 20,000 revolutions. The capacity as a track roller is based on 1/3 Aircraft Static Capacity (ASC).

To calculate the $L_{10}$ life, in revolutions, of a type ATF, ATL, NBF, and NBL bearing, the following formula should be used:

$$TL = \frac{20000}{\sum T_i \left( \frac{P_i}{CTR} \right)^6 + \sum t_i \left( \frac{P_i}{CTR} \right)^{10/3}}$$

Where $TL = \text{total life (} L_{10} \text{)}$
CTR = capacity as a track roller
$P_i = \text{loads greater than CTR}$
$p_i = \text{loads less than CTR}$
$T_i = \text{fraction of total revolutions at load } P_i$
$t_i = \text{fraction of total revolutions at load } p_i$

Under no circumstances should the applied load exceed the limit load rating.
In the case of types NBC, NCC, NBE, and NBK bearings, the ultimate load ratings correspond to the Aircraft Static Capacity. The limit load rating listed is 2/3 of the ultimate load rating.

Types NBC, NCC, NBE, and NBK bearings are generally applied where they carry only moderate loads while oscillating or rotating slowly, but they are expected to carry heavy static radial loads or shock loads. For this reason the basic (dynamic) load ratings are not listed. If the basic load ratings are required for specific bearings, please consult the RBC Aerospace Engineering Department.

If types NBE and NBK bearings are required to carry more than light loads while self-aligning, the torque required to overcome the friction between the spherical surfaces may add substantially to the radial loads on the rolling elements. Under such circumstances, please consult the RBC Aerospace Engineering Department.

Type HRS and HRSC track roller bearings have heat treated studs as such working loads are not limited by stud strength. The limit load ratings listed on the tabular pages correspond to 2/3 of ASC. The ultimate (static fracture) load ratings are not less than 1.5 times the limit load rating (ASC). The capacity as a track roller for 20,000 revolutions L10 life is 1/3 • ASC.

**TRACK CAPACITY**

When applying types ATF, ATL, NBF, NBL, HRS, and HRSC track roller bearings, the compressive strength of the track material is often the critical design factor for the application. Where listed, the track capacities are based on a track hardness equivalent to 40 HRC. For other hardness values multiply the track capacity listed on the tabular pages by the appropriate factor selected from Table 1.

When using track materials with high hardness, it must be remembered that the load applied to a bearing should not exceed the limit load for that bearing.

**TABLE 1**

<table>
<thead>
<tr>
<th>Track Hardness</th>
<th>Track Capacity Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>HRC</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>0.4</td>
</tr>
<tr>
<td>25</td>
<td>0.5</td>
</tr>
<tr>
<td>30</td>
<td>0.6</td>
</tr>
<tr>
<td>35</td>
<td>0.8</td>
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<tr>
<td>40</td>
<td>1.0</td>
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<tr>
<td>45</td>
<td>1.4</td>
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<tr>
<td>50</td>
<td>1.9</td>
</tr>
<tr>
<td>55</td>
<td>2.6</td>
</tr>
<tr>
<td>58</td>
<td>3.2</td>
</tr>
</tbody>
</table>
ENGINEERING FOR AIRFRAME CONTROL NEEDLE ROLLER BEARINGS

TEMPERATURE
The unsealed airframe needle bearings listed herein can be operated at temperatures up to 400°F (200°C) if a suitable lubricant is used. Subjecting these bearings to higher temperatures will result in a loss of capacity, which depends upon the length of time that the bearings are exposed to the higher temperature. Temperature differential between bearing parts should be watched to prevent take-up of internal clearance due to differential expansion.

The operating temperature of the sealed bearings is limited by the seal material and should not exceed 250°F (120°C).

The data herein permit tentative bearing selection, but before the application is finalized, please consult the RBC Aerospace Engineering Department.

SPECIAL BEARINGS
RBC supplies airframe bearings, in addition to types ATP and ATL, which are sealed to help retain lubricants and exclude foreign matter. For superior performance, the sealing arrangement has been designed to be capable of withstanding a pressure of 400 bar. We also supply bearings with special configurations, materials, protective finishes, tolerance, and lubricants. Please consult the RBC Aerospace Engineering Department.

SPEED
Airframe needle roller bearings are intended for use in low speed, high load applications. The bearing speed should not exceed 100 RPM. Speeds in excess of 100 RPM will greatly reduce the bearing life.

LUBRICATION
The most common greases used in aircraft track roller and cam follower applications are MIL-PRF-23827 TYPE 1 and MIL-PRF-81322 grease. Either grease is available for catalog items. If a specific grease is preferred, then specify it upon placing the order.

<table>
<thead>
<tr>
<th>Military Spec. No.</th>
<th>MIL-PRF-23827 TYPE 1</th>
<th>MIL-PRF-81322</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grease Name</td>
<td>Aeroshell 33®</td>
<td>Mobil 28®</td>
</tr>
<tr>
<td>Operating Temp.</td>
<td>-65°F to +250°F</td>
<td>-60°F to +350°F</td>
</tr>
<tr>
<td></td>
<td>-53°C to +120°C</td>
<td>-51°C to +177°C</td>
</tr>
</tbody>
</table>

OPERATING TEMPERATURES FOR BEARING COMPONENT MATERIALS

CHART 1 — RINGS AND ROLLERS

<table>
<thead>
<tr>
<th>Material</th>
<th>Approximate Chemical Analysis - %</th>
<th>Temp. °F</th>
<th>Minimum Hardness Rc</th>
<th>-100°F</th>
<th>-65°F</th>
<th>0°F</th>
<th>100°F</th>
<th>200°F</th>
<th>300°F</th>
<th>350°F</th>
<th>400°F</th>
<th>500°F</th>
<th>600°F</th>
<th>700°F</th>
<th>800°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>52100 per AMS 6440</td>
<td>1C 1.5Cr .35Mn</td>
<td>70</td>
<td>58</td>
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<td></td>
<td></td>
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<tr>
<td>Carbonizing steel per AMS 6620</td>
<td>2C .30Cr .010Mn .20Mo .50Ni</td>
<td>70</td>
<td>58</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Corrosion resistant 440C CRES per AMS 5880</td>
<td>1C 18Cr</td>
<td>70</td>
<td>58</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Pyroware 675 per AMS 5930</td>
<td>.38C .75Mn 13Cr 2.5Ni 6Co 2Mo .60V</td>
<td>70</td>
<td>58</td>
<td></td>
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<tr>
<td>Corrosion resistant steel per AMS 5655 with proprietary heat treat process</td>
<td>.22C 12Cr .75Ni 1Mo 1W .25V</td>
<td>70</td>
<td>58</td>
<td></td>
<td></td>
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<tr>
<td>Corrosion resistant 440C CRES per AMS 5880</td>
<td>1C 18Cr</td>
<td>70</td>
<td>58</td>
<td>55</td>
<td>52</td>
<td></td>
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<tr>
<td>M50 steel per AMS 6480 or AMS 6491</td>
<td>.00C 4Cr 4Mo 1V</td>
<td>70</td>
<td>58</td>
<td>55</td>
<td>52</td>
<td></td>
<td></td>
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</tbody>
</table>

Standard dimensional stabilization
Frequently used to achieve extra ductility for cam follower studs
Excellent corrosion resistance
Superior corrosion resistance and ductility for cam follower studs
Superior corrosion resistance and fracture toughness
Heat stabilized for maximum hardness at high temperatures. Good oxidation resistance at higher temperatures. Note load capacity drops off more rapidly at higher temperatures than M50 shown below, which should be considered if loads are high.
Recommended where stable high hardness at elevated temperatures is required.

Bearings have been made of special materials such as Haynes Alloy 25, BG42, etc., for operation at temperatures above 800°F (427°C).

Aeroshell 33® is a registered trademark of Shell Corporation.
Mobil 28® is a registered trademark of Exxon Mobil Corporation.

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Airframe needle roller bearings serve where weight and space are vital factors. They give high capacity anti-friction performance on flap tracks of large high-speed, high-altitude aircraft.

The high capacity and anti-friction characteristics of airframe needle roller bearings are ideal for canopy lock rolls where failure to operate may be fatal.

The small size and light weight of the airframe needle roller bearing permits reduction in material required in surrounding parts. The high capacity offers superior anti-friction operation under severe service conditions.

The high static capacity of the airframe needle roller bearing is an important factor in meeting the rugged impact loads found in aircraft landing gears. Small size and simple lubrication contribute to lighter assemblies and long service life.