Standardisation of Aerospace Bearings.

1.0 Introduction:

By definition, Bearing is a machine element that support another machine element while permitting relative motion between them. Similarly, bearings meant for aerospace also fall under the same category and based on the application in which it is used, i.e either in aircraft or in space vehicle, it is named so called "Aerospace Bearings". They can be broadly categorised into two categories as given below

(i) Control surface or Airframe Bearings
(ii) Power Transmission & engine Bearings

(i) Control surface or Airframe Bearings:

Control surface Bearings form a part of aircraft or space vehicles that controls the motion of the vehicles. These bearings are part of surface of the vehicles such as aileron, rudder, and rotor actuators, etc., and sometimes called as Airframe bearings. Most of the cases, these bearings do have oscillatory type of motions rather than one full rotation. Based on the functionality, these bearings can be sub categorised as given below

(a) Oscillatory bearings or plain spherical bearings or rod end bearings.
(b) Rolling element bearings.

(a) Plain Spherical and Rod End Bearings

Plain spherical and Rod end bearings are also used in industrial and automobile application. These bearings are similar and being used in aerospace application has same type and slight changes in configuration based on the user requirement. These bearings have the following components

- ✓ Outer ring
- ✓ Inner ring or rod end
- ✓ Liner housed or embedded in either of the rings

These bearings do not have rolling elements between the inner and outer rings.

Bearings for aerospace application differs in-terms of the conditions listed in the Table No.1 when compared to industrial and automobile application.

(b) Rolling element bearings

Rolling element bearings are widely used in industrial and automobile application. Bearings used for aerospace application is also of similar types and **differs only in-terms of the conditions listed in Table No 1.** The bearings also have components such as inner race, outer race, rolling elements, cage with certain special features for securing or assembly of bearings in the airframe

Table No. 1 : Aerospace Bearings requirements

Sl. No	Conditions / features of Aerospace bearings	Remarks
1	Premium quality materials (raceways, rolling element, cage, seals)	To meeting wide operating temperature (-ve to +ve). Better fatigue
2	Aero grade Lubricant	To meet wide operating temperature
3	Special features or integral feature on inner or outer race	To reduce weight of the component. Minimising components
4	Higher Reliability	Requirement of airborne
5	Plating	Operating environment

(ii) Power Transmission & Engine Bearings

Bearings used for Transmission of power and supporting engine main shaft in aerospace application has become challenge and rolling element bearings is the only promising solution in this segment with improvement made in this domain. These aerospace transmission bearings are all rolling element bearings and find distinct from industrial and automobiles bearings for the points mentioned below.

- ✓ Higher precision class
- ✓ Higher speed
- ✓ Made up of special bearings steel with premium quality CVEM , VIM & VAR
- ✓ Integral raceways such as flanged configuration facilitating mounting
- ✓ RNU type configurations
- ✓ 99% Reliability
- ✓ Special Plating / coatings on bearing components

2.0 Standardisation of Aerospace bearings

Unlike Bearings used in industrial and automobiles, the standardisation of bearings for aerospace application is challenging because, majority of the bearings are customised to suit its application. Over a period of time the usage of aerospace bearings are becoming commonality based on the similar environment and application.

These Aerospace bearings are also designed based on the ISO / ABMA / DIN / BIS standards, but few bearings are exempted from standard boundary dimension design because to meet the end aerospace customers need. So, Boundary dimension of these bearings may or may not be of the standard size.

(i) Airframe control surface bearings

Among airframe control surface bearings, rolling element bearings used for such application, standardisation methodology was matured on Airframe control surface in particular to military specifications such as MIL Standards (MS) and standard part catalogues are being made by each manufacturer complying to these specification. Later, the Military standards were converted to SAE specification and Aerospace Standards (AS) replaced the MIL standards.

Few of the Aerospace Bearings standard lists are given below.

Table No 2: Standards for Airframe control Bearings (Aerospace standard Series- *plain spherical bearings*)

Sl.No	Standard No	Nomenclature	Remarks
1	**AS 81820**	**Bearings, Plain, Self-Aligning, Self-Lubricating, Low Speed Oscillation, General Specification**	
2	AS 6039	Bearings, Ball, Rod End, Double Row, Self-Aligning	
3	AS 8976	Bearings, Plain, Self-Aligning, All Metal	
4	AS 8952	Bearings, Roller, Rod End, Antifriction Self-Aligning	
5	AS 8942	Bearings, Plain and PTFE Lined, Self - Aligning	
6	AS 8943	Bearings, Sleeve, Plain and Flanged, Self – Lubricating - 65 to +250 °F	
7	AS 8952	Bearings, Roller, Rod End, Antifriction Self-Aligning	
8	**AS 81934**	**Bearings, Sleeve, Plain and Flanged, Self-Lubricating, General Specification**	
9	**AS 81935**	**Bearings, Plain, Rod End, Self-Aligning, Self-Lubricating, General Specification**	
10	**AS 81936**	**Bearings, Plain, Self-Aligning, (BeCu Ball, CRES Race) General Specification**	

Table No 3: Standards for Airframe control Bearings (Aerospace standard Series- *Rolling element bearings*)

Sl. No	Standard No	Nomenclature	Remarks
1	AS 21428	Bearing, Ball, Airframe, Anti-friction, Extra Light Duty	
2	AS 21443	Bearing, Ball, Airframe, Anti-friction, Pulley	
3	AS 27640	Bearing, Ball, Airframe, Anti-friction, Heavy Duty	
4	AS 27641	Bearing, Ball, Airframe, Anti-friction, Intermediate Duty	
5	AS 27642	Bearing, Ball, Airframe, Extra Light Duty	
6	AS 27643	Bearing, Ball, Airframe, Anti-friction, Self-aligning, Double Row, Heavy Duty	
7	AS 27644	Bearing, Ball, Airframe, Anti-friction, Double Row, Heavy Duty	
8	AS 27645	Bearing, Ball, Airframe, Anti-friction, Self-aligning, Light and Heavy Duty	
9	AS 27646	Bearing, Ball, Airframe, Anti-friction, Extra Light Duty	
10	AS 27647	Bearing, Ball, Airframe, Anti-friction, Extra Wide, Double Row, Intermediate Duty	
11	AS 27648	Bearing, Ball, Airframe, Anti-friction, External Self-aligning, Extra Light Duty	
12	AS 27649	Bearing, Ball, Airframe, Anti-friction, Intermediate Duty (Stainless Steel)	
13	**AS 7949**	**Bearings, Ball, Airframe, Antifriction, General Standard**	
14	**AS 8914**	**Bearing, Roller, Self-Aligning, Airframe, Antifriction, General Standard**	

Of these above standards, the bearings are being manufactured, qualified and supplied as per the standards indicated in bold vide Table No. 2, Sl. No 1,8,9 &10 and Table No 3, Sl. No 13 & 14. Hence, development of Indian standards in Aerospace Domain can be initiated for these standards initially.

To create the Indian standards, the available SAE AS standards are required as a bench mark references and the content can be rephrased to the Indian Aerospace environment.

(ii) Power Transmission & engine Bearings

Bearings used for power transmission and engine main shaft are evidently rolling element bearings. These bearings are designed for end customer requirement and design varies based on the operating environment and assembly requirements. Hence, bearings in this segments are not popularly standardised, they are being customised. Wherever, engines are being generalised in terms of thrust rating and operating environment, the bearings can be selected / designed with common characteristics and being used with same part no.

Bearings for these segment of Aerospace also being manufactured, qualified and supplied same as Airframe Rolling element bearings with certain changes. For this domain, the standard given in Table no.4 forms a bench marking references.

Indian standards for this category will be new entry in this domain compared to the global scenario.

Table No 4: Standards for rolling element Bearings (Aerospace standard Series- *Rolling element bearings*)

Standard No	Nomenclature	Remarks
AS 7949	Bearings, Ball, Airframe, Antifriction, General Standard	
AS 8914	Bearing, Roller, Self-Aligning, Airframe, Antifriction	