EXECUTIVE SUMMARY

Scope of ISO/TC 4

Standardization of all types and all sizes of bearing elements based on the principle of rolling motion, their accessories, application and identification and standardization of spherical plain bearings, i.e. plain bearings with spherical contact surface.

The main field and the overall size of the markets addressed by the committee

Rolling bearings are mechanical components used in all kinds of stationary and mobile equipment. Rotating rolling bearings transmit loads from rotating to stationary machine elements with high precision and extremely low energy loss. Linear motion rolling bearings serve the same purpose in the transmission of linear movements. Spherical plain bearings are internally self-aligning and are used to accommodate slow or partial rotation with relatively low friction.

The size of the market in 2018 is estimated at a value of 50 billion euros (60 billion US $).

Note: exchange rate 2018/05/01: 1 euro = 1.20 US $ (2014/07/01: 1 euro = 1.36 US $)

Due to fluctuating exchange rates, only rough figures are presented.

The benefits already realized and/or expected through the availability of the standards

Assistance to the users in the selection, specification and application of appropriate rolling bearing products as well as ensuring interchangeability, irrespective of origin by:

— standardization of boundary dimensions and tolerances, thereby ensuring dimensional interchangeability,

— standardization of measuring principles, including Geometrical Product Specification (GPS) implementation, thereby ensuring uniform interpretation and evaluation of quality requirements,

— definition of performance criteria, thereby facilitating the consistent prediction of service performance, and impartial rational comparison of products.

— standardization of vocabulary and designations required to define the product.

The main objectives and the priorities in the work of the committee
The objectives of ISO/TC 4 are to standardize all types and all sizes of standard bearings and bearing elements based on the principle of rolling motion, their accessories, application, identification, characteristics and performance criteria. Similarly, the objective is also to standardize spherical plain bearings, i.e. plain bearings with spherical contact surfaces.

The main objectives of the committee are:

— to continue the standardization of the boundary dimensions, tolerances and measuring principles for products not yet standardized and new products,

— to implement GPS, where applicable

— to improve the methods for calculating bearing load carrying capacities and live prediction,

— to standardize vocabularies.
1. INTRODUCTION

1.1 ISO technical committees and business planning

The extension of formal business planning to ISO Technical Committees (ISO/TCs) is an important measure which forms part of a major review of business. The aim is to align the ISO work programme with expressed business environment needs and trends and to allow ISO/TCs to prioritize among different projects, to identify the benefits expected from the availability of International Standards, and to ensure adequate resources for projects throughout their development.

1.2 International standardization and the role of ISO

The foremost aim of international standardization is to facilitate the exchange of goods and services through the elimination of technical barriers to trade.

Three bodies are responsible for the planning, development and adoption of International Standards: ISO (International Organization for Standardization) is responsible for all sectors excluding Electrotechnical, which is the responsibility of IEC (International Electrotechnical Committee), and most of the Telecommunications Technologies, which are largely the responsibility of ITU (International Telecommunication Union).

ISO is a legal association, the members of which are the National Standards Bodies (NSBs) of some 161 countries (organizations representing social and economic interests at the international level), supported by a Central Secretariat based in Geneva, Switzerland.

The principal deliverable of ISO is the International Standard.

An International Standard embodies the essential principles of global openness and transparency, consensus and technical coherence. These are safeguarded through its development in an ISO Technical Committee (ISO/TC), representative of all interested parties, supported by a public comment phase (the ISO Technical Enquiry). ISO and its Technical Committees are also able to offer the ISO Technical Specification (ISO/TS), the ISO Public Available Specification (ISO/PAS) and the ISO Technical Report (ISO/TR) as solutions to market needs. These ISO products represent lower levels of consensus and have therefore not the same status as an International Standard.

ISO offers also the International Workshop Agreement (IWA) as a deliverable which aims to bridge the gap between the activities of consortia and the formal process of standardization represented by ISO and its national members. An important distinction is that the IWA is developed by ISO workshops and fora, comprising only participants with direct interest, and so it is not accorded the status of an International Standard.

2. BUSINESS ENVIRONMENT OF ISO/TC 4

This section establishes a sequential development of thoughts regarding the market for which ISO/TC 4 aims to fulfil the needs. Details in relation to the market analysis are given in the Guidance document on ISO Business Planning. The sequence of thoughts starts from a description of the current market situation relevant to the product or product grouping under consideration by ISO/TC 4, continues on to an analysis of the different factors motivating/influencing the activities of ISO/TC 4, to come to clear description of objectives and expected benefits resulting from the work of ISO/TC 4, together with an accompanying strategy how to reach those objectives. Finally, a general ‘risk analysis’ is included highlighting issues that may delay or stop the ISO/TC 4 achieving its set objectives.

2.1 Description of the Business Environment
The following political, economic, technical, regulatory, legal and social dynamics describe the business environment of the industry sector, products, materials, disciplines or practices related to the scope of this ISO/TC, and they may significantly influence how the relevant standards development processes are conducted and the content of the resulting standards:

2.1.1 General description of the market

2.1.1.1 Use of ISO/TC 4 Standards
More than 90% of the rolling bearing production is to ISO/TC 4 Standards for dimensions, tolerances or other parameters. Bearings to inch sizes and special bearings for particular applications make up the rest. Rolling bearings are produced in billions per year and bearings are one of the most essential products for industry and an important factor for the industrial development until today and in the future. To manufacture the billions of bearings without dimensional standards and provide interchangeability of replacement bearings from different manufacturers would be impossible. Rolling bearings are practically always manufactured according to the ISO/TC 4 Standards, a fact that is more or less self-evident, and therefore specifying an ISO Standard is mostly not needed. Competition is a guarantee that the standards are respected. When safety aspects are involved references to ISO/TC 4 Standards are often specified, e.g. in the CEN Standard EN 12080:2017 for railway axlebox rolling bearings. As rolling bearings are used everywhere in industrial machinery and in consumer products, the ISO/TC 4 Standards for dimensions, tolerances, etc. have an influence on a very large number of products, and the standards are often cited as normative references in standards outside the remit of ISO/TC 4 for other products and machinery etc. that interface with rolling bearings.

2.2 Quantitative Indicators of the Business Environment

The following list of quantitative indicators describes the business environment in order to provide adequate information to support actions of the ISO/TC:

2.2.1 Bearing sales of complete bearings
All larger bearing companies have production other than bearings, e.g. steel, housings and seals, but also products without connection to bearings. The published figures do not allow to extract the real bearing part. Hence only estimates can be given. The approximate figures for the 2017 world sales of complete rolling bearings into regions are given in Table 1.

Table 1 – Bearing sales of complete bearings

<table>
<thead>
<tr>
<th>Year</th>
<th>Total bearing sales</th>
<th>Western Europe (^a)</th>
<th>Americas (^b)</th>
<th>Asia (^c)</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>50 billion euros (60 billion US $)</td>
<td>25 %</td>
<td>20 %</td>
<td>50 %</td>
<td>5 %</td>
</tr>
</tbody>
</table>

\(^a\) In Western Europe Germany alone accounts for some 10 %

\(^b\) In the Americas, North America accounts for some 15 %, in South America Brazil is the major player with some 3 %

\(^c\) In Asia, China accounts for some 25 % (growing) and Japan for 15 %. Other Asian markets with sizeable bearing production account for about 10%, including India, Thailand, Indonesia, Malaysia and the Republic of Korea.

Note: exchange rate 2018/05/01: 1 euro = 1.20 US $
2.2.2 Employment
The number of employees worldwide, engaged in the rolling bearing business, is estimated to be well over 500,000, of which > 50% in China alone. The very tough competition has led to rationalization and reduction of employees and mergers between bearing producers in most countries. This has been a continuous process as well as an increased use of component suppliers. A very rough estimate of number of employees in the bearing sector in the six largest companies in 2017 is shown in Table 2. People that are not directly involved in the bearing business are not considered.

<table>
<thead>
<tr>
<th>Number of employees 2014</th>
<th>Rolling bearing companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 30,000</td>
<td>SKF, Schaeffler</td>
</tr>
<tr>
<td>&gt; 20,000</td>
<td>Timken, NSK, JTEKT</td>
</tr>
<tr>
<td>&gt; 10,000</td>
<td>NTN</td>
</tr>
</tbody>
</table>

2.3 Description of the market structure and the major market players

2.3.1 Structure of the market: Suppliers/Manufacturers (descriptive and quantitative)

2.3.1.1 Major product categories, tendencies and their relative market shares
Roughly estimated, the share of ball bearings, of various designs, account for more than half of the world market, while different roller bearings make the balance. This share has been stable for a number of years.

The most popular of the ball bearing types is the deep groove ball bearing, which accounts for about one third of the total world bearing market. Other ball bearings are angular contact, self-aligning and thrust ball bearings, and hub bearing units for automotive applications, such as wheels and suspension assemblies.

The roller bearings are cylindrical, spherical, tapered or needle roller bearings. The most common of the roller bearing types is the tapered roller bearing, with a share of less than 20% of the total world bearing market. Sales of this type of bearing have declined over the last 20 years, as wheel hub bearing units incorporating balls have replaced tapered roller bearings to a large extend.

Spherical, cylindrical and needle roller bearings have together kept around the same world market share slightly over 20% of the bearing world market.

The share of large size bearings is increasing due to new applications, e.g. for renewable energy applications such as wind turbines.

2.3.1.2 Major manufacturers and their market shares - bearing companies
The estimated number of sizeable rolling bearing manufacturing companies in the world is 200.
If smaller bearing manufacturers would be accounted for, the total is raised to over 3000. There is a continuous trend for concentration, although there were no major changes over the past 10 years.

The six largest world bearing companies can be found in Table 3. It is estimated that these top 6 represent about 60% of the global rolling bearing market.

Table 3 – Six largest world bearing companies

<table>
<thead>
<tr>
<th>Main rolling bearing companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>SKF</td>
</tr>
</tbody>
</table>
The Chinese bearing market is fragmented, with the main international bearing companies accounting for about one third of the market while the other two thirds of the market consists of a host of local manufacturers. Some of the largest include: C&U, Wanxiang Qianchao, Wafangdian(ZWZ), Luoyang(LYC), Zhejiang Tianma (TMB), and Cixing Group(CW).

2.3.2 Structure of the market: Customers (descriptive and quantitative)
Rolling bearings are not end products. They are components in industrial machinery equipment and consumer products. The main customers can be found in manufacturing industry and among end users.

Among the bearing users, the entire automotive industry dominates. The sales to this market are around 30 % of the world bearing market. The corresponding figure for manufacturers of industrial machinery is around 40 % and for the industrial aftermarket 30 %.

2.4 Major factors which may have an impact on the development of the markets

2.4.1 Bearing Industry
The rolling bearing market has a large customer base and is, therefore, dependent upon the world economy.

The recession that started in 2008 and lasted through 2009 had a serious negative impact on the world market. The world bearing manufacturers have improved their business performances due to recovery of the rolling bearing world demand. However, business is still very tight and only small increases in the total market are forecasted (some 7 % by 2018). There is still an over-capacity in bearing production in the world, and a tough competition is to continue. Cost reduction will be of the utmost importance.

In Western Europe, the gradual recovery of the economy is expected to continue, but slowly.

In USA, small increases in market are prognosed.

In Asia, China, but also India see large increases in local demand, both for local consumption and expanded private sector demand as well as an increase of the exportation.

Risks are still there due to the evolution of exchange rates – Euro versus Dollar and Yen.

2.4.2 Technological trends
During the last 60 years, the production of rolling bearings has been driven by industrial development; however, this development pattern is changing and has changed importantly during recent years.

On important point is digitalization. It influences manufacturing, purchasing, maintenance, etc. It means shorter lead-times and smaller inventories to reduce costs. The performance requirements have also changed. In many applications trouble-free operation of the bearings for the entire life of the equipment is required e.g. motor vehicles. In other applications the requirement is for maximum reliability and long periods between service e.g. railway goods wagons and locomotives, power plants, windmill operations. In machine tool spindles and electric motors, high precision and low vibration levels are of paramount importance. Very special demands for high precision and safe operation at extreme temperatures are the primary concern for bearings in aircraft jet engine main shafts. Higher speeds are required for new generation products used in existing applications, e.g.
vacuum cleaners, alternators. There is also a trend for having more capacity in less space; a
typical example is automotive gearbox bearings.

To respond to these demands, the rolling bearing industry is continuously improving products
in many respects, including design, material composition and cleanliness, heat treatment and
the entire manufacturing process.

The cleanliness of the bearing material is of particular importance and together with other
improvements, a modern bearing running under very clean operating conditions, can be expected
to obtain a very long service life – under certain load and operating conditions an almost infinite
life.

For the predictable future, it is expected that the use of rolling bearings will follow industrial
development to a large extent. Electronics cannot replace the equipment in which rolling bearings
find widespread use. Rolling bearings will therefore continue to maintain their significance in the
industrial society, even if distribution and use of electric energy, production machines, rail, road
and air transport, etc. may change in the future, not the least by the influence of information
technology (IT), Internet and other new technologies.

One important aspect that has come up over the recent years is how to get the best performance
out of a bearing – cost wise but also from the environment point of view. This is particularly true for
large size bearings and for a number of specific applications such as railway and continuous
casters. Bearings are core components of plant assets, and they can take a lot of punishment.
Usually bearings are either replaced during planned maintenance when nearing the end of their
operational life or after unplanned breakdowns. Depending on the bearing type, replacement can
be expensive and may involve long lead times. In addition, scrapping of “end of life” bearings may
have a negative impact on a company’s sustainability – an aspect that is becoming increasingly
important to investors and customers. Remanufacturing can increase the service life of bearings in
order to decrease downtime, reduce cost and scrap.

Plain bearings have an obvious use but can only marginally compete in the classical bearing field.
Hydrostatic, air and magnetic bearings will find their use in very specialized areas.

The classical rolling bearing types were established many years ago. No new bearing types were
introduced over the last 10 years.

There has been a slow change in the use of the classical bearing types over the years. The
tendency is an increased market share for ball bearings and a reduction for tapered roller
bearings. In the automotive sector ball bearing hub units and tapered roller bearing hub units for
wheels are being extensively used instead of conventional designs with tapered roller bearings.

A hub bearing unit can combine the elements of bearing, housing and shaft. It represents a
confirmed tendency in the bearing industry to supply complete sub-units, where the bearing is part
of the equipment with added properties. Mechatronics is another example, where a bearing unit
combines its bearing function with the sensor for an ABS braking system. A further example of the
development of a new bearing in the field of mechatronics is the integration of an electronic cell
inside the bearing which can measure speed, acceleration, sense of rotation and/or angular
position with a better degree of precision than systems used at present. These bearings are mainly
used in electric motors for speed control or in trucklifts for position control (replacement of the
mechanical steering). New applications can also be found in railway bearing units and large size
bearings in heavy industry, mainly windmill applications.

2.4.3 Technical barriers and other regulatory issues

The need for standardization was recognized by the manufacturers of rolling bearings in the
1920s. Basic dimensional standards were established by ISA in the 1930s. Work was resumed in

The standardization work has mainly engaged the bearing manufacturers, but in the different
national standardization bodies, the customers have also expressed opinions. For example, the
standardization of carrying capacities and life calculations was initiated by the American military
organization, as there had been purchasing problems, during the Second World War, when comparing the expected performance of replacement bearings from different suppliers.

The standardization work has been free from restrictions. From the beginning, the need for interchangeable replacement bearings and high volume production initiated dimensional standards followed by the customers need for a common system for calculation of load carrying capacities, lives, etc.

2.4.4 Environmental issues
Environmental care is becoming increasingly important. With proper measures, the bearing industry is a very clean industry.

Recycling of residual products is common. Chips can be recycled 100%. A high percentage of used oils, paper, carton and grinding swarf can be recycled.

Cleaning liquids, such as trichloroethylene, can for example be replaced by water based cleaning liquids. There are large bearing factories where no trichloroethylene is used.

Certification to the environmental management system standard ISO 14001 is of course important and many bearing companies have been certified.

ISO/TC 4 is product oriented and environmental issues are not included in the scope but have to be considered, e.g. when designing rubber components for sealed bearings and when selecting greases for such bearings.

However, one aspect that needs to be considered here is re-manufacturing. There is not only potential cost savings of between 50 to 80% of the cost of a new bearing. Remanufacturing of used bearings can reduce CO$_2$ emissions. Remanufacturing 100 kg of used bearings leads to a reduction of about 350 kg CO$_2$.

2.5 Acceptance of the ISO/TC 4 Standards

For manufacturing and selling rolling bearings the standards worked out by ISO/TC 4 are of utmost importance. These standards are widely accepted and all common bearing types are produced according to the standards. However, bearings with specific dimensions are also produced. One example is bearings with inch dimensions. Although externally not conforming to standard dimension series, these special bearings typically adopt appropriate ISO/TC4 standards for internal features.

2.6 Benefits expected from the work of ISO/TC4

It has already been explained above that rolling bearings have been essential for the manufacturing of industrial products and in the development of new products. As bearings are produced in extremely large numbers and with many thousands of variants, the ISO/TC 4 Standards have been, and remain, indispensable for bearing manufacturers and users. This is valid for all stages in the process from bearing manufacturing, storage, sales and distribution. The end user needs the standardized products when selecting and purchasing bearings and when designing his product in order to obtain good performance and easy mounting and replacement of bearings.

3. MEMBERSHIP

The participation in ISO/TC4, of P-members (Participating Members) and O-members (Observing Members) can be seen here:
https://www.iso.org/committee/45544.html?view=participation

3.1 Analysis of the participation
All P-members come from developed countries. The reason for this is that the rolling bearing industry is based on very specialized, large scale production, and participating P-members mainly come from countries with rolling bearings in their production programme. There are participants from all regions of the world. Liaisons with other organizations are with FEM (European Federation of Handling Industries) and WCO (World Customs Organization).

Internal ISO liaisons are with:

ISO/TC 10/SC 6: Technical product documentation; Mechanical engineering documentation
ISO/TC 17/SC 4: Steel; Heat treatable and alloy steels
ISO/TC 20: Aircraft and space vehicles
ISO/TC 28: Petroleum and related products, fuels and lubricants from natural or synthetic sources
ISO/TC 39: Machine tools
ISO/TC 108/SC 2: Mechanical vibration, shock and condition; Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures
ISO/TC 123: Plain bearings
ISO/TC 123/SC 2: Plain bearings; Materials and lubricants, their properties, characteristics, test methods and testing conditions
ISO/TC 123/SC 3: Plain bearings; Dimensions, tolerances and construction details
ISO/TC 123/SC 6: Plain bearings; Terms and common items
ISO/TC 206: Fine ceramics
ISO/TC 213: Dimensional and geometrical product specifications and verification
ISO/TC 269/SC 2: Railway rolling stock

4. OBJECTIVES OF THE ISO/TC AND STRATEGIES FOR THEIR ACHIEVEMENT

4.1 Defined objectives of the ISO/TC

Based on the considerations above, ISO/TC 4 proposes the following objectives and strategic directions for its future work:

The objectives of ISO/TC 4 are to standardize all types and all sizes of bearing and bearing elements based on the principle of rolling motion, their accessories, application, identification, characteristics and performance criteria. Similarly, the objective is also to standardize spherical plain bearings, i.e. plain bearings with spherical contact surfaces.

4.2 Identified strategies to achieve the ISO/TC’s defined objectives

The main objectives of the committee are:

— to continue the standardization of the boundary dimensions, tolerances, measuring principles for products not yet standardized and new products,
— to improve the methods for calculating bearing load carrying capacities and live prediction,
— to standardize vocabularies.

4.2.1 Strategies adopted to reach objectives

With the purpose of assisting the user in the selection, specification and application of correct rolling bearing products as well as ensuring interchangeability, irrespective of origin, the strategy of ISO/TC 4 is:

— standardization of boundary dimensions and tolerances, thereby ensuring dimensional
interchangeability,
— standardization of measuring principles, thereby ensuring uniform interpretation and evaluation of quality requirements,
— definition of performance criteria, thereby facilitating the consistent prediction of service performance
— standardization of vocabulary and designations required to define the product.

Consider differentiating between load/life and limiting speed testing and vibration testing. How do we justify some performance calculations such as load/life, speed rating, thermal rating, without some reliance on test results?

ISO/TC 4 is a long standing committee, which was originally established in 1926 by the International Standards Association as committee ISA 4. Therefore, the fields in need of standardization are to a large extent covered by today’s ISO/TC 4 Standards. Very few new bearing types are standardized. Standards have been made and are being made for linear motion bearings regarding dimensions, load carrying capacities and vocabulary.

Over the years the quality of the bearing steel has been improved and also the machining accuracy in bearing production. It is possible today to improve the bearing cleanliness throughout operation, e.g. by using sealed bearings or by selecting improved filtering of oil circulating systems. The standardized methods for calculating bearing load carrying capacities and lives have been and will be adapted to all these improvements.

European Standards have not yet been used as a basis for ISO/TC 4 Standards, but national standards as DIN, ABMA etc. are sometimes used as a basis or as initiation of work for new or improved standards.

The standardization work is carried out by physical meetings and, where possible, by correspondence via Internet. The use of the ISO Livelink system has facilitated the work of committees and project leaders and has resulted in a reduction in the time for producing standards.

English is used at the meetings and the need for translation is normally not required. Of the ISO deliverables, International Standards dominate and are preferred, but in exceptional cases Technical Reports have been used and recently also Technical Specifications.

The work within ISO/TC 4 and its subcommittees is mainly based on research results and knowledge from the different bearing companies and their sub-suppliers and practical experience from bearing applications. External research is not used to support the work of the ISO committees, and there is thus no need for funding to cover research costs. Originally ISO/TC 4 consisted of the head committee and a number of working groups. As there was a tendency and also a need to keep some working groups permanent, it was decided to transform the working groups for special bearing types into subcommittees. Besides a subcommittee for “Load ratings and life”, subcommittees for “Tolerances” and the common bearing types have been established.

Changing needs led also to the establishment of a new Subcommittee in 2011, SC 12: Ball bearings, under the responsibility of JISC (Japan). Changes were also made to the scope and responsibilities of the other SCs.

5. FACTORS AFFECTING COMPLETION AND IMPLEMENTATION OF THE ISO/TC WORK PROGRAMME

The demand on the Secretariats to deliver the DIS and the FDIS with the aid of a template still means a lot of work and increased cost for the ISO/TC 4 Secretariat and the Secretariats of the subcommittees. However, this does not influence the time for completion of standards.

Two SC's of ISO/TC 4 are not situated on the ISO TC server (SC 7 and SC 8), requiring separate log-in for the members.
P-members voting discipline is acceptable, both on ISO/TC and ISO/TC 4/SCs levels. However, often too many P-members abstain of voting. A frequent problem for the active experts in the working groups is lack of time to spend on standardization. The daily work takes up most of their time. This can cause delay, but the problems are mostly overcome well.

6. STRUCTURE, CURRENT PROJECTS AND PUBLICATIONS OF THE ISO/TC

Information on ISO online

The link below is to the TC’s page on ISO’s website:

Click on the tabs and links on this page to find the following information:

- About (Secretariat, Secretary, Chair, Date of creation, Scope, etc.): [https://www.iso.org/committee/45544.html](https://www.iso.org/committee/45544.html)
- Contact details: [https://www.iso.org/committee/45544.html](https://www.iso.org/committee/45544.html)
- Structure (Subcommittees and working groups): [https://www.iso.org/committee/45544.html](https://www.iso.org/committee/45544.html)
- Liaisons: [https://www.iso.org/committee/45544.html](https://www.iso.org/committee/45544.html)
- Meetings: [https://www.iso.org/committee/45544.html](https://www.iso.org/committee/45544.html)
- Work programme (published standards and standards under development): [https://www.iso.org/committee/45544/x/catalogue/p/1/u/0/w/0/d/0](https://www.iso.org/committee/45544/x/catalogue/p/1/u/0/w/0/d/0)

Reference information

[https://www.iso.org/governance-of-technical-work.html](https://www.iso.org/governance-of-technical-work.html)