A Bearing Is in Most Danger Not While It Turns but Just Before It Stops

— Since the minimum film thickness goes as the **0.68** power of speed, a bearing with a film parameter of **3.0** at full speed falls to **1.872496** at half speed, **1.004203** at a fifth and **0.626789** at a tenth — the separator is whether the film parameter exceeds one — [Paper 712]

Yuuki YAMAGISHI (山岸 勇輝)
Yamagishi Complexity Torus Lab, Japan
September 2026

— From thinking to syncing. —

Abstract

Bearings are designed with a steady rotation in mind. But the oil film is made by speed, so it thins as the speed falls.Where the film runs out, and how far the life falls beyond it, is counted here.No new theorem or law is claimed. First, the film is made by speed——the minimum film thickness goes as the 0.68 power of speed, so slowing down thins it (Section 2). **Second, ample margin at full speed does not survive to low speed——a film parameter of 3.0 becomes 1.872496 at half speed, 1.004203 at a fifth and 0.626789 at a tenth** (Section 2). **Third, and this is the core. It drops below one at 0.198770 of full speed——long before stopping, at a fifth of full speed, the boundary has already been crossed** (Section 2). **Fourth, beyond the boundary the life falls by orders——taking the life to change by 100 or by 1000 between film parameters of 1 and 3 gives exponents of 4.191807 and 6.287710** (Section 3). **Fifth, at those exponents the life at low speed is a thousandth——0.001411 of the life at full speed, at a tenth of full speed** (Section 3). **Sixth, the separator is whether the film parameter exceeds one——the design is fixed not by the steady state but by the worst moment** (Section 4). **Keywords**: film parameter, minimum film thickness, transition to boundary lubrication, bearing life, danger at low speed, design fixed by the worst moment.

Scope of this paper (scope note): **No new theorem or law is claimed——the division of lubrication regimes by the film parameter, the speed dependence of the minimum film thickness and its effect on life are all standard (Hamrock and Dowson 1981, Harris and Kotzalas 2006).No life equation is used——no bearing life equation is invoked; the life exponent is inverted from the assumption that life changes by 100 or 1000 between film parameters of 1 and 3.The exponent is not claimed——the speed exponent 0.68 is a representative value and moves with the type of bearing and the conditions.Practice is not treated——the number of starts and stops, the supply of lubricant and preload are not treated.Mechanism is not discussed——the mechanisms of wear are not treated.Relation to earlier papers**: **Paper 711 showed that along the same axis of film thickness the friction coefficient has a valley, and that the non-monotonicity lives only in the sum of two terms——there an interior optimum was seen on that axis; here a boundary is. The horizontal axis is shared, and changing the vertical one turns “there is an optimum” into “there is a line not to be crossed”.**What is added is **tabulating the film parameter against speed**, **putting the speed at which it drops below one at 0.198770**, **inverting two life exponents and showing the second to be exactly 1.5 times the first**, **putting the life at low speed at 0.001411**, and **placing the separator on the film parameter exceeding one**.

1. Notation and the Question

Setting: **call the minimum film thickness divided by the roughness the film parameter. The thickness goes as a power of speed.**

$$\Lambda(v) = \Lambda_0\, v^{\,0.68}, \qquad v_1 = \Lambda_0^{-1/0.68}, \qquad L(\Lambda) \propto \Lambda^{m}, \qquad m = \frac{\ln R}{\ln 3}$$

Here v is speed with full speed as 1, and R the ratio of lives between film parameters of 1 and 3. Take $\Lambda_0 = 3.0$.

Question: **when is a bearing in most danger?**

2. Slowing Down Breaks the Film

Computation 2.1: **the film parameter was derived at each speed.**

speed	film parameter
100 %	3.000000
50 %	1.872496
20 %	1.004203
10 %	0.626789
5 %	0.391220

Computation 2.2: the film parameter drops below 1 at 0.198770 of full speed.

> **Observation 2.3**
>
> this is the core: the boundary lies at a fifth of full speed, not just before stopping.Even with an ample 3.0 at full speed, falling to 0.198770 already reaches it——"take care only at the instant of stopping" comes too late.

> **Observation 2.4**
>
> tripling the margin in film costs five times the speed.With an exponent of 0.68, tripling the film parameter requires $3^{1/0.68} = 5.030937$ times the speed——because the exponent is below one, margin bought on the side of speed is expensive.

3. Beyond the Boundary, Life Falls by Orders

Computation 3.1: taking the life to change by 100 or by 1000 between film parameters of 1 and 3 gives exponents of 4.191807 and 6.287710; the second is exactly 1.5 times the first.

Computation 3.2: at those exponents, the life at each speed, with full speed as 1, follows.

speed	life (exponent from 100)	life (exponent from 1000)
100 %	1.000000	1.000000
50 %	0.138655	0.051630
20 %	0.010177	0.001027
10 %	0.001411	0.000053

Observation 3.3

the life at a tenth of full speed is only 0.001411 of the life at full speed.The time spent turning slowly is a small share of the whole, and almost all the damage happens there——a share of time and a share of damage are entirely different quantities.

Observation 3.4

so the design is fixed by the worst moment, not by the average.Securing $\Lambda = 3$ in the steady state leaves the life to be decided by the number of times the machine passes through starting and stopping——a design that looks only at rated conditions is not looking at what happens.

Observation 3.5

the uncertainty in the exponent does not change the conclusion.Assuming 100 or 1000, the life at a tenth of full speed is 0.001411 or 0.000053, falling by three orders either way——the conclusion is sturdier than the spread in the assumption.

4. The Separator

> **Observation 4.1**
>
> **the separator is whether the film parameter exceeds one.Above it the surfaces do not touch; below it they do, and from that moment the life follows another law——a speed that varies continuously carries a discontinuous consequence at one point.**

> **Observation 4.2**
>
> **beside Paper 711.Paper 711 showed a valley in the friction coefficient along the same axis of film thickness, the non-monotonicity living only in the sum of two terms——there an interior optimum was seen on that axis; here a boundary is. Changing the vertical axis turns “there is an optimum” into “there is a line not to be crossed”.**

> **Observation 4.3**
>
> **what is not said.No life equation, practice or mechanism of wear is treated, and every exponent is representative——what is shown is that the boundary sits at a fifth of full speed, not just before stopping.**

5. Roll Call and Closing

1. **1.872496 at half speed** (Computation 2.1): **margin remains.**
2. **1.004203 at a fifth** (Computation 2.1): **the boundary is reached.**
3. **0.626789 at a tenth** (Computation 2.1): **it has been crossed.**
4. **below one at 0.198770** (Computation 2.2): **the core.**
5. **tripling the film needs 5.030937 times the speed** (Observation 2.4): **the exponent is below one.**
6. **life exponent 4.191807** (Computation 3.1): **assuming a factor of 100.**
7. **6.287710 assuming 1000** (Computation 3.1): **exactly 1.5 times.**
8. **life 0.001411 at a tenth** (Computation 3.2): **three orders down.**
9. **0.000053 on the other exponent** (Computation 3.2): **the conclusion holds.**
10. **does the film parameter exceed one** (Observation 4.1): **the separator; Paper 711.**

Closing: **A bearing is in most danger not while it turns but just before it stops.Since the minimum film thickness goes as the 0.68 power of speed, even a film parameter of 3.0 at full speed falls to 1.872496 at half, 1.004203 at a fifth and 0.626789 at a tenth.It drops below one already at 0.198770 of full speed——long before stopping, the boundary has been crossed——and because the exponent is below one, tripling the film parameter demands 5.030937 times the speed, so margin bought on the side of speed is expensive.Beyond the boundary the life falls by orders——taking the life to change by 100 or 1000 between film parameters of 1 and 3 gives exponents of 4.191807 and 6.287710, and the life at a tenth of full speed is 0.001411 or 0.000053.The conclusion is sturdier than the spread in the assumption.The separator is whether the film parameter exceeds one.Placed among the earlier papers——in Paper 711 the same axis carried an interior optimum; here it carries a line not to be crossed.To be honest——no life equation or practice is treated, and every exponent is representative.**

References

1. Hamrock, B. J., & Dowson, D. (1981). *Ball Bearing Lubrication*. Wiley.
2. Harris, T. A., & Kotzalas, M. N. (2006). *Rolling Bearing Analysis*. Taylor & Francis.
3. Yamagishi, Y. (2026). *“Better Lubrication Means Less Friction” Holds Only on the Near Side of the Minimum* [Paper 711]. Zenodo. 10.5281/zenodo.23014946

— *From thinking to syncing.* —

Yuuki YAMAGISHI (山岸 勇輝)

© 2026 Yamagishi Complexity Torus Lab, Japan · Licensed under Creative Commons Attribution 4.0 International (CC BY 4.0)