Exploring key features that work together to create the ultimate coating

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Introduction

The authors reviewed the unique physical and performance characteristics of HOYA Vision Care's new advanced AR surface treatment, **Super HiVision® Meiryo™ EX4™.**

Quantifying an anti-reflection (AR) treatment is not a simple or easily defined process. Thorough and in-depth testing is important and needs to be performed to help define the evolution of today's AR treatments.

> **The most desired functional components were being able to see more clearly, extreme scratch resistance and full UV protection.**
>
> VisionWatch 2019 consumer survey

AR treatments in the past

Originally, AR treatments were designed to solve only two visual functional problems:

1. Lens reflection. Mainly their purpose was to reduce the amount of light reflecting from the surface of a lens, which according to the international standard ISO 8980-4 the luminous reflection off and anti-reflected surface needs to demonstrate less than 2.5% reflectance (ISO8980-4, Section 4.2).

2. Clarity. By allowing less light to be reflected, more light will be transmitted through the spectacle lens to reach the eye, hence improving clarity, and reducing unwanted ghost images created by the lens surface reflections.

AR treatments today

While the above is the standard definition of an AR treatment, today's coating technologies have improved AR treatments to include additional benefits, such as greater clarity, superior scratch resistance, and long lasting cleanability.

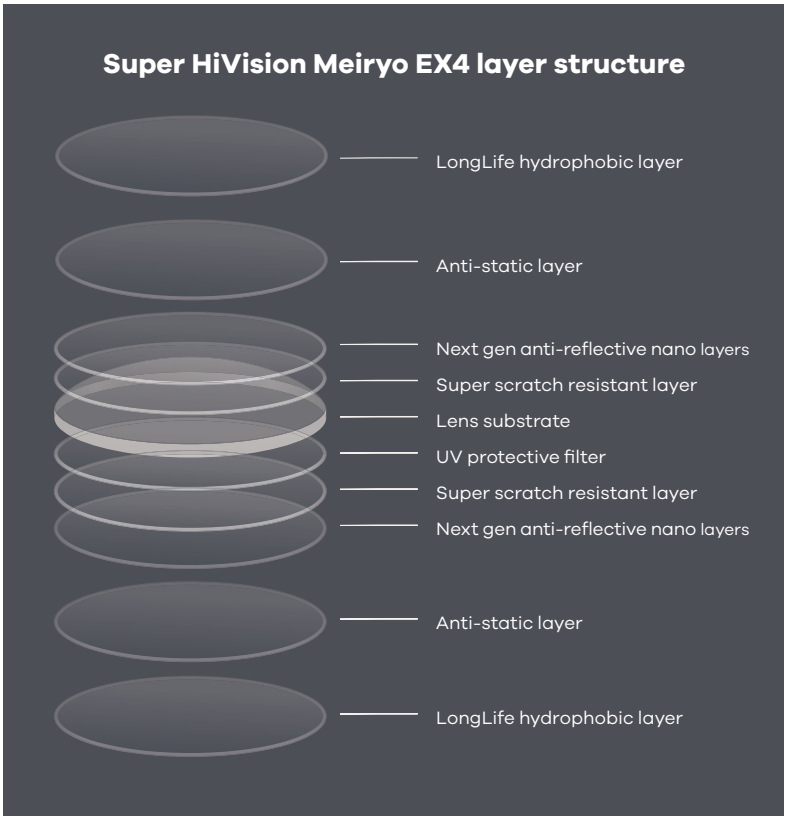
Every lens manufacturer now incorporates these functional properties into their AR coatings; however, **not all coatings or treatment technologies are equal in their quality and/or effectiveness.**

All premium AR treatments are comprised of "stacks" or layers that are designed to eliminate reflections from specific components or wavelengths of the visible light spectrum. Each layer of the Super HiVision coating process is specifically engineered to work with the other layers, by matching the adhesion and optical properties of the AR stack.

This process creates a very robust surface for the hard coat and the subsequent 9-layer AR "stack" to be laid upon, and every subsequent layer is specifically engineered to work in conjunction with every other layer to create one of the most durable and robustly protective AR treatments on the market.

Taking AR treatment to a new level: Super HiVision Meiryo EX4

HOYA's new AR treatment, Super HiVision Meiryo EX4 utilizes these advanced technologies using enhanced methods to take AR treatments to a new level. To help define the improved benefits of Super HiVision Meiryo EX4, **HOYA performed extensive testing in five unique categories** to evaluate specific performance advantages over leading competitors and previous generations of AR treatments.



Testing was performed to evaluate:

- Visual clarity
- Durability of cleanability
- Scratch resistance to abrasion
- Thermal resistance
- Resistance to peeling

These tests focused on a 2019 consumer survey through VisionWatch detailing the **most desirable benefits consumers wanted in an AR treatment.** The most desired functional components were being able to see more clearly, improved scratch resistance, and full UV protection. The two main complaints of AR treatments from the study were that AR treatments scratch too easily and are too hard to keep clean. **This is where HOYA focused to improve and ended up exceeding their goals.**

Introduction of the LongLife Index (LLI)

LongLife Index

The LongLife Index (LLI) is a measure of the performance and durability of anti-reflective lens treatments. This evaluation method is made up of five tests that are more rigorous than common industry standards, to provide Eye Care Professionals (ECPs) and patients with the HOYA quality guarantee for long-lasting anti-reflective treatments.

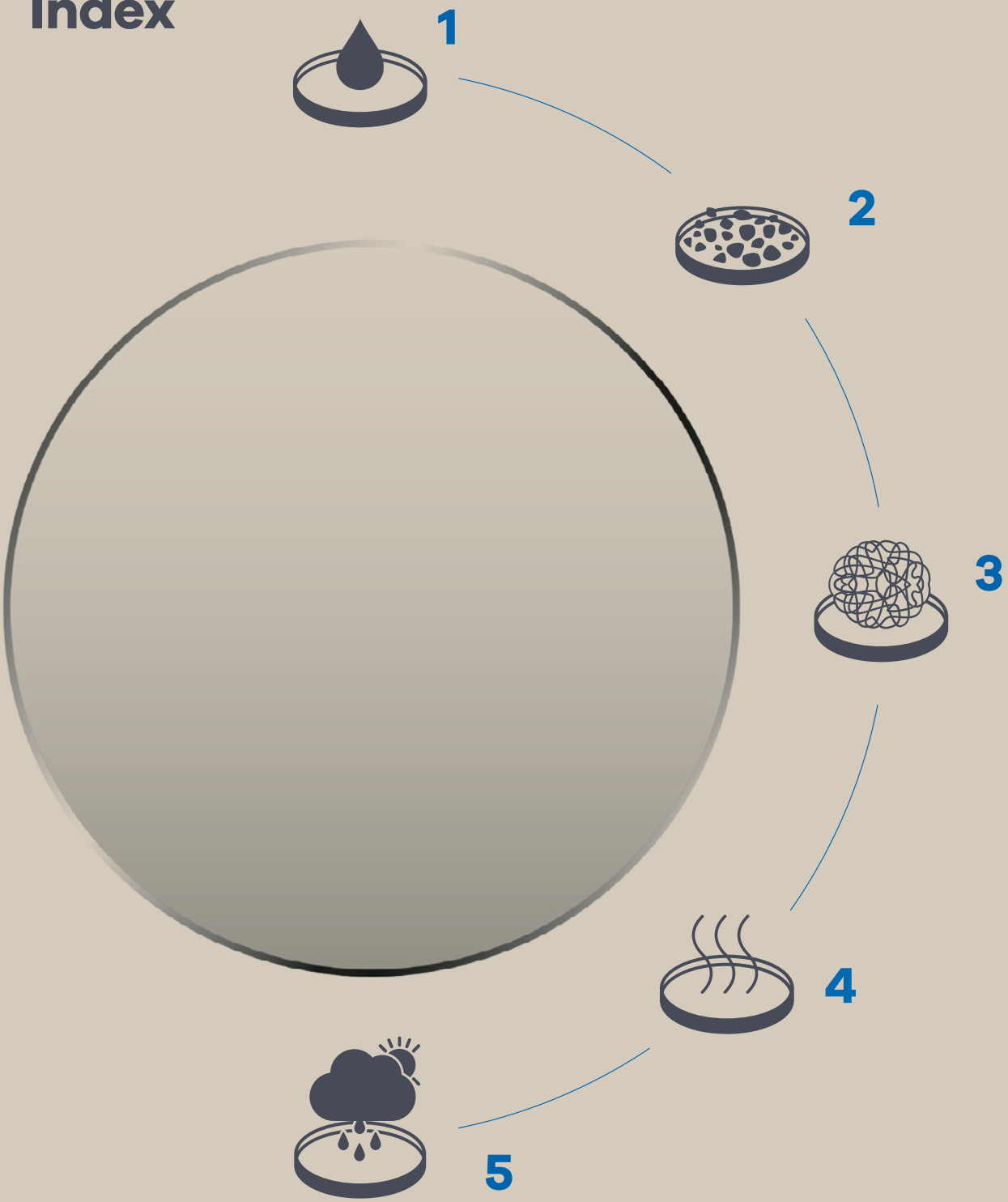
The LongLife Index (LLI) is a measure of the performance and durability of anti-reflective spectacle lens treatments.

The LLI was developed and adopted by HOYA as a working standard. Passing the more rigorous tests provides ECPs and consumers with the confidence that a coating is of the highest quality and is able to endure extreme conditions and various lifestyles.

The LLI composite score may be considered in the same way that other categories measure overall performance based on a series of individual measurements. Various categories will publish rankings of participant composite scores to help industry professionals and consumers make smarter decisions about the relative strengths of competitive product performance.

Index examples include: • Consumer Reports Product Ratings: (using a composite score that considers performance, reliability, user satisfaction, safety, and other relevant criteria); • J.D. Power Vehicle Dependability Study: (The composite score considers aspects like vehicle quality, reliability, and overall owner satisfaction); • Environmental Performance Index (EPI) assesses countries' environmental performance (Air quality, water resources, biodiversity, climate change, waste management); • European Health Consumer Index (EHCI) (Evaluates healthcare systems in European countries on Accessibility, patient rights, waiting times, treatment outcomes, etc.

LongLife Index



Tests that are included in the LongLife Index (LLI)

1. **Droplet test –** The spectacle lenses are wiped with dust-free optical lens wiping paper (harsher than a cleaning cloth or tissue) up to 5,000 times. After each 500 wipes, water droplets are applied to the surface of the lenses. The shape of the droplets on the surface determines the amount of hydrophobic coating left behind, and thus demonstrates how slippery the lenses are, indicating how easy they are to clean.
    - **Relevance:** The more spherical the droplet, the higher the water contact angle, the more hydrophobic properties are present; the flatter the droplet, the less hydrophobic properties are present.

2. **Sandpit test (HOYA Bayer value) –** Tests the coatings' resistance to abrasion. The spectacle lenses are placed in a 'sandpit' full of gravel and are shaken left-to-right 800 times. The lenses are then analyzed for transparency and the HOYA Bayer value is calculated.

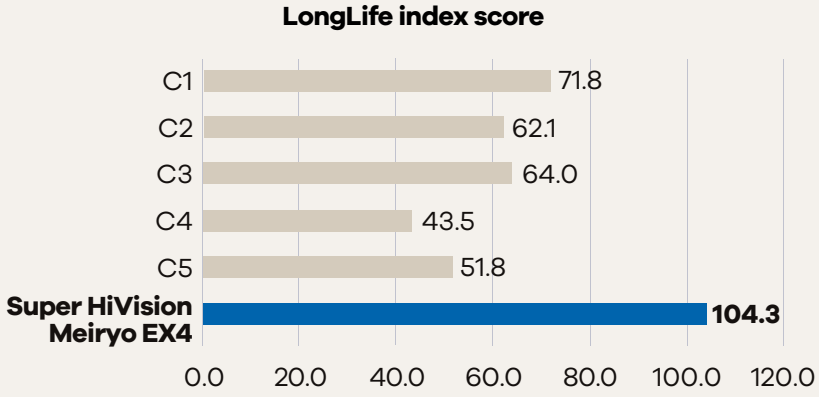
3. **Steel wool test –** This test uses weighted carbon steel wool to assess the coatings' resistance to harsh scratches caused by a forceful application of sharp material. This test uses weights up to 2.5kg which applies pressure onto the steel wool, and moves side-to-side 40 times (20 cycles) across the lens surface. The lenses are then analyzed for scratches under artificial lighting.

4. **Oven test –** Lenses are inserted into a laboratory-graded oven, and the temperature is gradually increased until the cracking point of the coating. The pass temperature for this test is 95˚C (203° F), which is hotter than the temperature inside a car on a hot summer day.

5. **Extreme weather test –** The lenses are put into a machine called a QUV accelerated weathering tester. The machine tests the lenses by exposing them to cycles of ultraviolet (UV) light and moisture at elevated temperatures – just like the harsh equatorial climate. The remainder of coating is measured every week up to a total of 4 weeks. This is combined with a cross hatch test to reveal the amount of peeling from the lens surface. 90% remainder after 4 weeks passes the test.
    - Cross hatch cuts are made in week 0 and then a special tape is applied and removed after each week to determine the amount of coating that remains at that stage.
    - The QUV simulates the effects of sunlight with fluorescent UV lamps, and dew and rain using condensing humidity and/or water spray.

LLI comparative performance

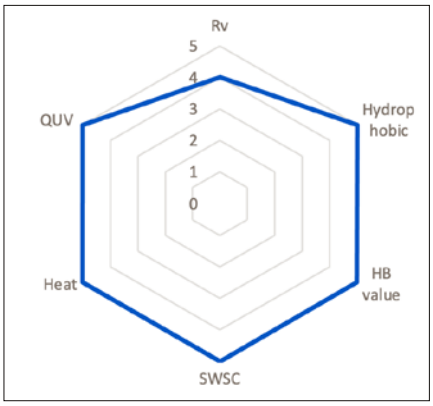
The groundbreaking results achieved through this rigorous process are significant. **Super HiVision Meiryo EX4 achieves the highest LLI score at 104, 45% higher than major competitor's best coating.** These attributes work synergistically to establish Super HiVision Meiryo EX4 as the ultimate coating.



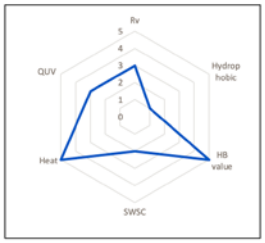
LLI comparative performance charts display results of 5 LLI tests and Luminance Reflectance % (Rv) of Super HiVision EX4 and other leading AR coatings represented on a 0-5 point scale.

Rv - Luminous reflectance
Hydrophobic - Water contact angle
HB value - HOYA Bayer value
SWSC - Steel Wool Scratch test
Heat - Heat resistance
QUV - Weathering Durability

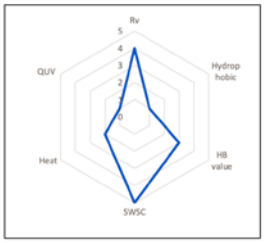
Super HiVision Meiryo EX4



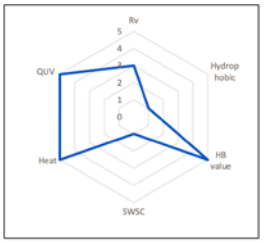
Competitive lens 1



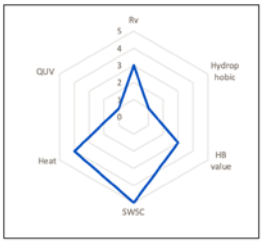
Competitive lens 2



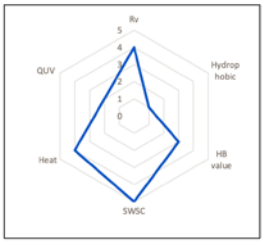
Competitive lens 3



Competitive lens 4



Competitive lens 5



The test results shown above were adapted in a scale from 0 to 5.

Real world benefits of Super HiVision Meiryo EX4's lens surface durability

Clarity is the most common desire for every spectacle wearer, and the defined function of an AR treatment is to reduce surface reflections and thus improve light transmission. By comparison, **Super HiVision Meiryo EX4 has demonstrated 56% lower reflectance than major competitor's best coating.**[1] This improved light transmission results in exceptional clarity. But it's not just the initial clarity of the lenses when they are first purchased that matter, but how that clarity holds up over time with cleaning and the wear and tear of daily life.

How the surface of a lens holds up to daily cleaning and maintenance has an impact on visual clarity over time. One way to measure the lens surface durability is by monitoring the water contact angle after cleaning the lenses thousands of times. The water contact angle is the angle between a droplet's edge and the surface underneath it. If that contact angle is greater than 90 degrees, the surface is considered to be hydrophobic. The water contact angle of a brand-new lens with AR treatment ranges from 108 to 118 degrees on average. Testing the breakdown of a lens surface consists of measuring the water contact angle after every 500 cleaning wipes and ending the test when the contact angle drops below the 100-degree level. The wipes are set to ensure a consistent swipe pattern and equal pressure. Performing this test resulted in many competitors AR treatments 'falling out' after the first 500 wipes. One competitor reached 1000 wipes and another even lasted 2000 wipes. **HOYA's Super HiVision Meiryo EX4 lasted 2.5 times longer,** making it to 5000 wipes without falling below the 100 degree contact angle (101 degrees). This long-life durability indicates that **Super HiVision Meiryo EX4 maintains 'easy clean' features up to 5X longer than all competitor's coatings tested.**[2]

One of the complaints that causes the most frustration for patients is when their lenses get scratched. This is not only aesthetically unappealing, but it can also affect the clarity through the lens. **Durability and scratch resistance** is a major component required in an AR treatment as reported in several surveys. It has been suggested that most spectacle wearers clean their lenses a couple times a day and this is typically not done with a standard cleaning cloth. So, 10-20 wipes per cleaning, twice a day for a year is 7,300-14,600 wipes. Extending this over two to three years can mount up to 21,900-43,800 wipes. Durability matters over a lifetime, even just considering the cleaning of the lenses alone!

The Sandpit test and Steel wool test described on page 7 as part of the LLI protocols both demonstrated over **2 times better at abrasion resistance than several competitive coatings.**[4]

Besides superior clarity, ease of cleaning and scratch resistance, an AR treatment should be able to **hold up to the environmental elements** no matter if you live in the rain forest, the desert, or the Arctic rim. Extreme weather fluctuations can damage metal, plastic and glass...so imagine what can it do to the surface of a lens.

Visually, you want a coating to hold its reliability throughout its lifetime. Putting AR treatments through 4 weeks of accelerated exposure to humidity, high temperatures, UV light and adhesion testing is an example of how the lens will stand up in the real world.

When exposed to the extreme weather test, **Super HiVision Meiryo EX4 was found to retain over 90% of its coating properties at the end of the 4 weeks of testing.** Most showed significant loss of their film structure as early as one week. Super HiVision Meiryo EX4 also showed the highest amount of heat resistance than all other AR treatments. Durability of a lens treatment through normal wear and tear of daily life and its exposure to any weather condition is an important part of a lens treatment and Super HiVision Meiryo EX4 stands above all others.

Competitive comparison summary of key features

Overall, Super HiVision Meiryo EX4 **demonstrates exceptional performance** in all the areas that matter.

Competitive Feature Comparison	MEIRYO EX4	Comp 1	Comp 2	Comp 3	Comp 4	Comp 5
Visual clarity	*****	***	****	***	***	*****
Durability of cleanability/ Lasting durability	*****	*	*	*	*	*
Durability	*****	*****	***	*****	***	***
Scratch resistance	*****	**	*****	*	*****	*****
Thermal resistance/ Workability	*****	*****	**	*****	****	****
Resistance to peeling	*****	***	*	*****	*	**

HOYA data on file. Product assessment report – Hi-Vision Meiryo. 05/2023 [1-6]

Super HiVision Meiryo EX4 stands out as a superior AR treatment in many facets:

1. Super HiVision Meiryo EX4's low reflectance results in ultimate clarity, with **56% lower reflectance than major competitor's best coating.**[1]
2. Its extreme durability gives it up to **2.5 times better scratch resistance and up to 2 times better abrasion resistance** than competitive coatings tested.[3,4]
3. Super HiVision Meiryo EX4 maintains its **'easy clean' features up to 5X longer** than all competitive coatings tested.[5]
4. Super HiVision Meiryo EX4 offers **superior clarity that lasts longer.**[6]
5. Super HiVision Meiryo EX4 provides **100% UV protection** from the front and the back of the lens.[8]

Purchasing glasses is an investment for clear and comfortable vision and it happens about every 1 to 3 years on average. Utilizing a premium treatment like Super HiVision Meiryo EX4 will ensure your patients' lenses stay in 'like-new' condition throughout their lifetime. Super HiVision Meiryo EX4 performs better than major competitor's overall in key features that work together to create the ultimate coating.[7]

References

1. HOYA data on file. Product assessment report – Hi-Vision Meiryo. 05/2023. The reflection has been calculated based on the reflection values measured in the Luminous reflectance Rv evaluation.
2. HOYA data on file. Product assessment report – Hi-Vision Meiryo. 05/2023. Hi-Vision Meiryo maintains 'easy clean' features up to 5X longer than all competitor's coatings tested.
3. HOYA data on file. Product assessment report – Hi-Vision Meiryo. 05/2023. Compared to several competitor coatings including major competitor's best coatings. Passed 2.5kg SWSC test when most competitive lenses tested did not pass 1kg in the SWSC.
4. HOYA data on file. Product assessment report – Hi-Vision Meiryo. 05/2023. Hi-Vision Meiryo performed over 2x better than several competitive coatings in the HB test. Hi-Vision Meiryo demonstrate best in class surface durability through both HB and SWSC tests.
5. HOYA data on file. Product assessment report – Hi-Vision Meiryo. 05/2023. Hi-Vision Meiryo maintains Hydrophobic performance up to 5X that of all competitive coatings tested.
6. HOYA data on file. Product assessment report – Hi-Vision Meiryo. 05/2023. Hi-Vision Meiryo lasts longer than all major competitors. 56% lower reflectance than major competitor's best coating resulting in exceptional clarity. Hi-Vision Meiryo maintains Hydrophobic performance up to 5X that of closest competitors.
7. The LongLife Index (LLI) is a measure of the performance and durability of anti-reflective lens coatings, made up of five tests (Droplet test, Sandpit test, Steel wool test, Oven test, Extreme weather test) that are designed to resemble the severity of real-world challenges, providing patients with the HOYA quality guarantee for long-lasting anti-reflective coating.
8. HOYA data on file. 1.50 UV approved claims. 09/22. Claim based on internal assessment according to ISO 8980-3:2022 and is applicable to HOYA branded plastic lenses except 1.50 standard lenses. The following HOYA lenses meet the strictest AS/NZS 1067.1:2016 standard for 100% protection: 1.50 UV, 1.53, 1.59 CBF, 1.60, 1.67, and 1.74.

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