



# Choosing an **ENGINE OIL** for Your Bike

**What's the right oil for my bike?** Oh no, not another oil thread! How many times have we heard that on the MOA Forum or in other discussions when a group of motorcyclists get together? Figuring out which oil to use can be a difficult process and a personal one. There are many choices on the market, and weeding through them can take time.

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## Background

Given that oil is the lifeblood of our engines, the selection of a product should include some investigation. Being an engineer, I thought performing some baseline tests would be appropriate. I take my direction from a couple of excellent past *Owner's News* articles written by Jeffrey DiCarlo (October 1999) and revisited by Matt Parkhouse in January 2002. Jeff provided a thorough discussion of the problem facing motorcyclists at a time when the American Petroleum Institute (API) was changing the oil classification for gasoline engines. The classifications are two-letter designations such as SG or SH. When Jeff was preparing his article, the newest classification was SJ. Today, the oil classification has risen to SN.

Matt considered new oils that had been introduced as well as finding oils with ratings of SL on the shelves at the time. He also focused more on motorcycle oils rather than a more general category of oils as presented by Jeffrey. Matt tested for chemistry just as Jeff did, but he also added information about total acid neutralizers, which was the sum of the concentration of the compounds boron, magnesium and calcium.

The big issue then (and still today) was the decrease of important additives in oil to better serve the many, many automobile owners whose catalytic converters were becoming contaminated over time. These additives were vaporized during the combustion process and finding their way into the converters. The fact that motorcycle engines comprised a much smaller segment of the community and most didn't have catalytic converters really had no bearing on the direction the API was taking.

The primary additives being reduced were zinc and phosphorous and are commonly referred to as ZDDP, or zinc dialkyldithiophosphates. ZDDP is an anti-wear compound and is beneficial to prevent metal-to-metal contact when oil begins to break down. It remains quite effective during critical periods such as engine cranking. So it would seem that using oils with high enough levels of ZDDP would be good for our engines.

In an oil update in August 2009, Matt recommended that the

minimum level of ZDDP should be 1000 parts per million (ppm) each of zinc and phosphorus and that 1500 ppm is ideal. Anything over 2000 ppm can be excessive and even lead to formation of deposits in the engine. Additional online research found at [www.LNEngineering.com](http://www.LNEngineering.com) suggests that optimal levels of zinc and phosphorus should be in the 1200–1500 ppm range. This is especially true for older engines that use the flat tappet or cam follower design.

So what is the right oil for your bike? The first place you should look is the owner's manual for BMW's recommendation. That recommendation should come in the form of an oil grade and viscosity range for the expected temperature operations.

## Oils Selected for Testing

The idea to perform another round of oil analysis started on the MOA Airhead Forum, so the primary focus on testing was oils that would be suitable for the engines of the period 1970 to the late 1990s. Engines prior to 1970 can certainly benefit from the information presented here, but other issues can be important for them, such as the choice between detergent and non-detergent oil due to the slinger-based oiling system. Likely many BMW engines built after 2000 also require some of the same oil specifications of the Airhead engine, although the actual viscosity range might be different. Later models that have converters or engine sensors may require different oil. Again, check your manual. All but one of the oils in this analysis have a viscosity range of 20W-50, as that is the specified range for general operation of the Airhead engine. But hopefully there's something here for everyone!

The oils selected were drawn from the many oil threads I've read over the years. They represent oils used by a wide variety of owners and, for the most part, are readily available through local outlets. Jeff and Matt tested some of the oils, so there is some continuity with the earlier articles. As seen in Tables 1 and 2, the oils were purchased at local retailers, motorcycle-only stores and a few from online companies. The tables list the manufacturer, common name and type of oil along with where to purchase it and the cost (excluding shipping as necessary).

**Table 1: Oils – Brand and Ratings**

Brand	Name	Viscosity	Type	API Ratings
Spectro	Spectro4	20W-50	Petro	SL
BMW	4-Stroke	20W-50	Petro	SG/SH
Castrol	GTX	20W-50	Petro	SJ/SL/SM/SN
Castrol	4T	20W-50	Petro	SG/SH
Valvoline	VR1 Racing Oil	20W-50	Petro	SG/SL/SM/SN
Valvoline	4-Stroke	20W-50	Petro	SF/SG/SJ
Shell	Rotella T	15W-40	Petro	SM
Brad Penn	Penn Grade 1 V2 4-Stroke M/C Oil	20W-50	Petro	SG/SH/SJ
Liqui Moly	Racing 4T Motorcycle Oil	20W-50	Petro	SG/SJ/SL
Harley	Motorcycle Oil	20W-50	Petro	HD 360
Spectro	Golden4	20W-50	Blended	SL
Castrol	ActEvp X-tra 4T	20W-50	Blended	SG
BMW	Super Synthetic	15W-50	Synthetic	SG/SH
Mobil 1	V-Twin	20W-50	Synthetic	SG/SH/SJ
Castrol	Power RS V-Twin 4T	20W-50	Synthetic	SL
AMSOIL	Motorcycle	20W-50	Synthetic	SG/SL
Motul	7100-4T	20W-50	Synthetic	SG/SH/SJ/SL
Red Line	Motorcycle Oil	20W-50	Synthetic	SG/SH/SJ

**Table 2: Oils – Price and Availability**

Brand	Name	Quantity	Seal?	List Price (pre-tax)	Available
Spectro	Spectro4	Liter	Yes	\$6.99	Cycle Gear
BMW	4-Stroke	Quart	Yes	\$10.20	Dealer
Castrol	GTX	Quart	No	\$4.58	Wal-Mart
Castrol	4T	Liter	No	\$5.99	O'Reilly
Valvoline	VR1 Racing Oil	Quart	No	\$5.99	AutoZone
Valvoline	4-Stroke	Quart	No	\$6.79	CARQUEST
Shell	Rotella T	Quart	No	\$3.64	Wal-Mart
Brad Penn	Penn Grade 1 V2 4-Stroke M/C Oil	Quart	No	\$6.95*	Pace Performance
Liqui Moly	Racing 4T Motorcycle Oil	5 Liter	Yes	\$37.95*	Beemer Boneyard
Harley	Motorcycle Oil	Quart	No	\$7.49	Dealer
Spectro	Golden4	Liter	Yes	\$9.99	Cycle Gear
Castrol	ActEvp X-tra 4T	Quart	Yes	\$7.49	Cycle Gear
BMW	Super Synthetic	Quart	Yes	\$16.70	Dealer
Mobil 1	V-Twin	Quart	No	\$12.99	Cycle Gear
Castrol	Power RS V-Twin 4T	Quart	Yes	\$12.99	Cycle Gear
AMSOIL	Motorcycle	Quart	No	\$12.99	Local M/C Shop
Motul	7100-4T	Liter	Yes	\$12.98	Local M/C Shop
Red Line	Motorcycle Oil	Quart	Yes	\$13.99	Cycle Gear

\*Online purchase; shipping was extra

Of interest are oils that come with internal seals on the bottles. Having an environmental seal might help to preserve the shelf life of the oil. Two of the oils, Liqui Moly and Motul, even had built-in plastic spouts. I was also surprised at the colors of some of the oils. In my world, oil has always been golden colored. However, the Brad Penn oil was green while the Motul and Reline products were red.

## Oil Analysis Results

The laboratory used is the same general company that did the testing for the earlier articles. The analyses performed were for three major categories: oil chemistry (levels of ZDDP), oil viscosity and total base number (TBN). The level of ZDDP was required to be 0.10

percent (or 1000 ppm) for SJ oils, down from 0.12 percent for SG/SH oils. It is the additive package that makes a base-stock oil (that is the 20 in 20W-50) a multi-weight oil (the 50 in 20W-50). When blending oil, the engineers have a range to meet in order to qualify for a 50-weight oil. Between oil change cycles, the viscosity improvers degrade and the rating of the oil can change with it. Thus, if an oil is blended to be in the upper part of the 50-weight viscosity range, despite degradation over time, it will still remain a 50-weight oil. TBN provides some information about the reserve levels of additives that are present to deal with the acids that are produced during the combustion process. Table 3 presents the numerical values from the testing.

**Table 3: Laboratory Results**

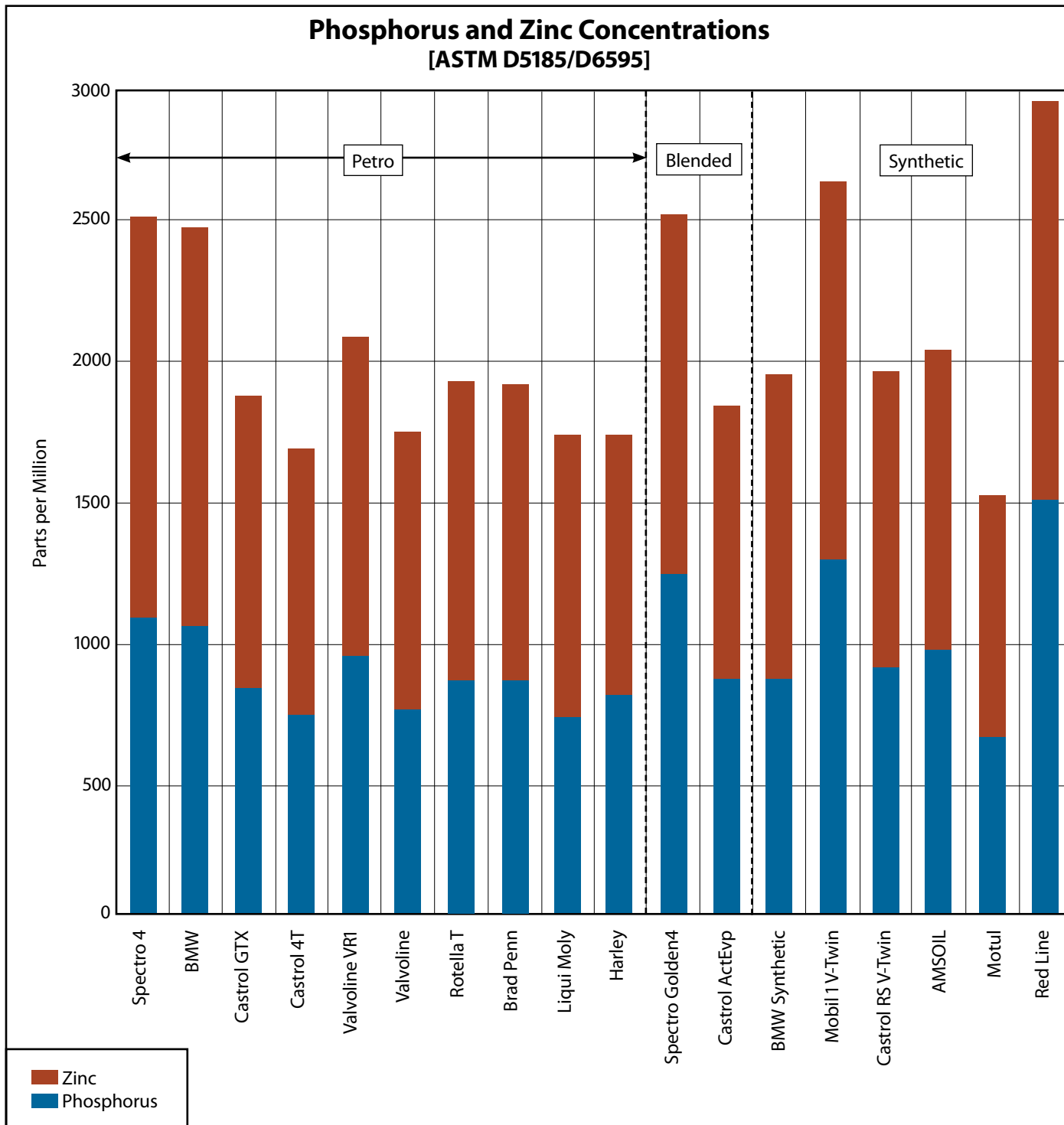
Brand	Name	Phosphorus (ppm)	Zinc (ppm)	Viscosity (Cst at 100 degrees C)	Total Base Number (mgKOH/g)
Spectro	Spectro4	1125	1386	19.46	7.38
BMW	4-Stroke	1072	1382	18.22	7.16
Castrol	GTX	828	997	18.8	8.06
Castrol	4T	758	924	19.92	8.05
Valvoline	VR1 Racing Oil	959	1135	20.07	8.97
Valvoline	4-Stroke	786	944	19.12	8.85
Shell	Rotella T	864	1018	15.6	9.82
Brad Penn	Penn Grade 1 V2 4-Stroke M/C Oil	862	1012	19.25	9.87
Liqui Moly	Racing 4T Motorcycle Oil	742	985	17.79	9.02
Harley	Motorcycle Oil	816	916	19.87	10.7
Spectro	Golden4	1058	1238	18.94	6.57
Castrol	ActEvp X-tra 4T	860	959	19.25	7.62
BMW	Super Synthetic	838	1108	19.77	7.42
Mobil 1	V-Twin	1293	1367	19.72	9.6
Castrol	Power RS V-Twin 4T	890	1069	20.61	8.78
AMSOIL	Motorcycle	988	1059	19.52	11.41
Motul	7100-4T	713	822	18.55	8.16
Red Line	Motorcycle Oil	1517	1435	18.97	8.87

## Chemistry Results

Figure 1 presents the data from Table 3 for the levels of zinc and phosphorus. The figure shows the first 10 samples that represent the oil types that were the basic petro type, the two that were considered blended samples, and the last type, which was full synthetic. At the bottom of each set of columns in Figure 1 is the highest API rating for each sample.

It can be seen that some oils with an API rating higher than SH have elevated ZDDP quantities. This is likely due to the fact that these oils are motorcycle-specific and are the “heavy” weights of 40 and 50. Oils that are not designed for automobile use have a bit more latitude regarding their chemical composition. In addition, a less volatile formulation of ZDDP could be used which would not damage catalytic converters but still be present for anti-wear functions.

**Figure 1: ZDDP Comparison**



## Viscosity Results

Figure 2 shows the viscosity levels from the testing for each sample. The blending of an oil to create a multi-weight oil is controlled by the amount of viscosity improvers in the oil. For each weight there is a range over which an oil can fall and still be categorized as that weight of oil. For 50W, the range is 16.3 to 21.89 centistokes measured at 100 degrees C temperature. Figure 2 shows where each oil fell within its respective range. Plotted against the right-hand axis is where each given oil falls in the range with a reading of 50 percent, indicating it fell in the middle of the range, that is, have a viscosity rating of about 19.1. Between oil change intervals, the viscosity improvers degrade and the weight of the oil can change. Ranking higher within the weight range would mean that an oil will likely retain its weight properties longer.

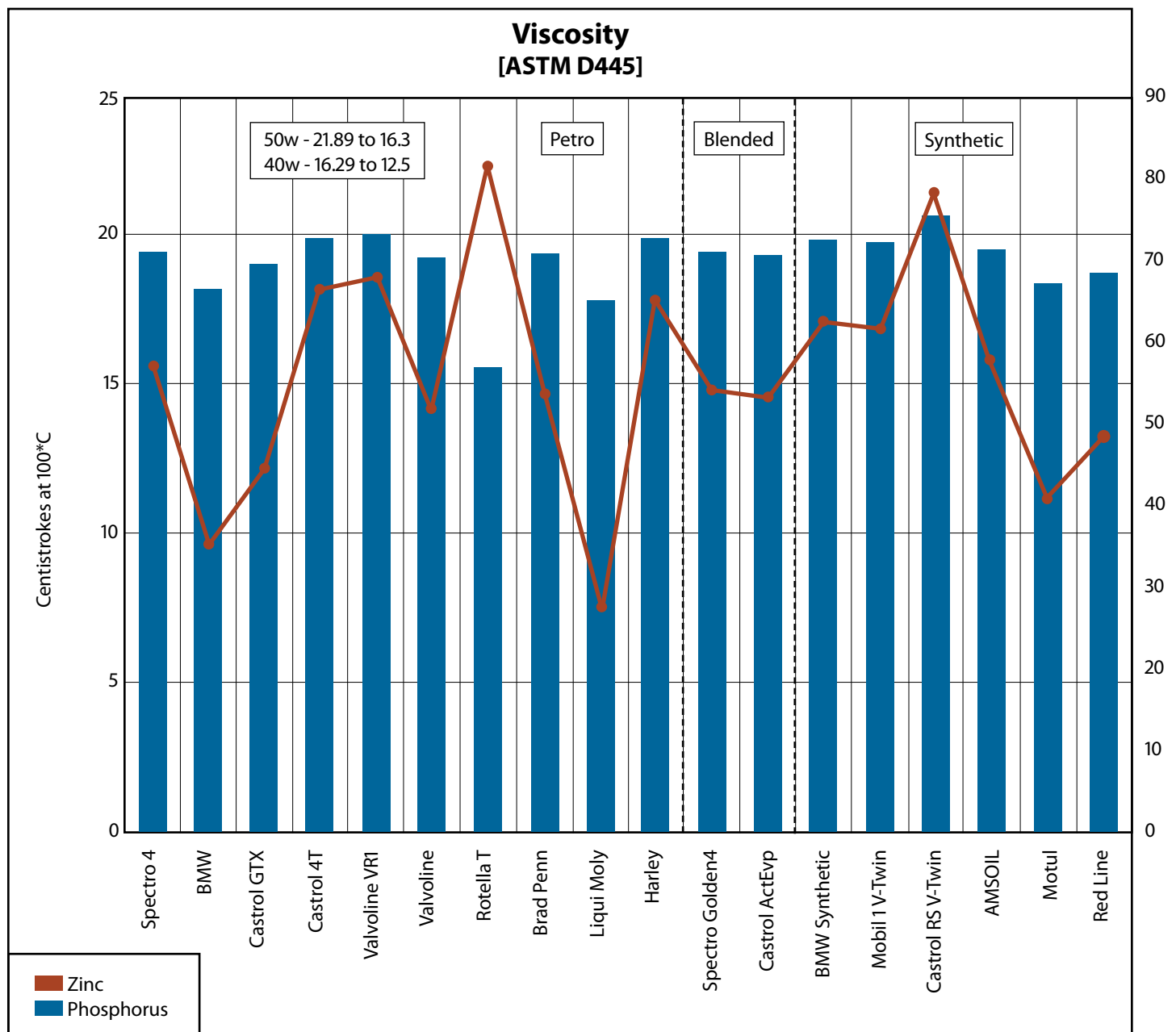
## Total Base Number Results

Figure 3 shows the total base number (TBN) for each of the oils. This is a measure of the ability of the oil to absorb the acids produced during combustion. This is usually a factor that synthetic oils take advantage of to support longer change intervals. One of the synthetics (MOA16) and one of the petro oils (MOA10) stand out in this regard.

## Summary

Comparing these results to the past articles for similar oils tested, it appears the concentrations of ZDDP are typically lower than they used to be. In some cases the differences are dramatic, as with the Spectro products, BMW's petro oil and AMSOIL. ZDDP remains an important parameter for anti-wear and anti-corrosion in the older engine designs. It may be important to include the strength of the viscosity rating as well as the quality of the acid neutralizer package when choosing an oil.

**Figure 2: Viscosity Comparison**



In the end, we should at least live by the universal credo – dirty oil is better than no oil and clean oil is better than dirty oil. But choosing the right oil can make all the difference and provide peace of mind – priceless!

Acknowledgments

Paul Graves had an opportunity to review the article and results; he offered some helpful comments and suggestions.

All testing was done by Bently Tribology Services in Minden, Nev. They provided the bottles, which were filled with 100 ml of

each sample of oil. Results were available within 3–4 days after receipt of the samples. Such services can also be useful to measure the amount of contaminants in used oil samples to determine the best time to schedule change intervals. This can be useful for fleet operations of vehicles.

Local merchants donated several of the oil samples. A bottle of AMSOIL was provided by Kyle, whose company can be found at [www.alamo-oil.com](http://www.alamo-oil.com). Joe at Cycle Gear in San Antonio provided six different bottles. The company website and store locator can be found at [www.cyclegear.com](http://www.cyclegear.com).

Figure 3: Total Base Number Comparison

