

MTBF, AFR and you

Summary: *MTBF is the most widely misunderstood concept in consumer storage. There's something better: AFR. Here's what AFR means and a handy MTBF to AFR conversion table.*

By [Robin Harris](#) for [Storage Bits](#) | February 8, 2011 -- 08:24 GMT (00:24 PST)

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MTBF is the most widely misunderstood concept in consumer storage. There's something better: AFR. Here's what AFR means and a handy MTBF to AFR conversion table.

The 200 year drive I often see forum comments like "a 1.6 million hour MTBF means this drive will last 200 years!"

Nope.

Disks have motors, bearings and lubricants that wear out or break down. There are plenty of 10 year old drives that still work, but [research from Google and CMU](http://www.zdnet.com/blog/storage/disk-drive-life-depends-on--luck/156) (<http://www.zdnet.com/blog/storage/disk-drive-life-depends-on--luck/156>) shows failures start climbing at 3 years.

So back 'em up, bunky.

MTBF and AFR MTBF (Mean Time Between Failures) is a statistical measure relevant to large populations. If you only have a few drives the reliability you see has little statistical significance.

But people still want to know what to expect from their disk drives. That's why the industry is moving to a more transparent number: the **Annualized Failure Rate or AFR**.

The AFR, or its cousin the **Annualized Return Rate or ARR**, give a better view of the chance of a drive failure in any given year. The ARR takes into account that about 60% of all returned this drives are NTF or No Trouble Found when tested.

Converting from MTBF to AFR/ARR This table presents the MTBF, the AFR and the ARR - assuming a **40% NTF** rate - so you know what to expect for a given MTBF.

Annualized Failure Rate (AFR) & Annualized Return Rate (ARR) Conversion from MTBF (hours)		
MTBF	AFR	ARR
25,000	29.56%	49.27%
300,000	2.88%	4.80%
500,000	1.74%	2.89%
750,000	1.16%	1.94%
1,000,000	0.87%	1.45%
1,200,000	0.73%	1.21%
1,400,000	0.62%	1.04%
1,600,000	0.55%	0.91%
1,800,000	0.49%	0.81%
2,000,000	0.44%	0.73%

(http://www.zdnet.com/i/story/60/88/001274/mtbf_to_afr_table.png)

The AFR is still a statistical construct. And it's only accurate for the first 3 years. After that AFR begins to climb.

If you buy a drive that fails two months later - as sometimes happens - you just got the 1 or so drives out of 100 that fails.

Poor you, but think of the happy owners of the 98 or 99 drives that didn't fail. When you have 40 or 50 of the same drives you can start judging the accuracy of the vendor specs. Want to know the chance of failure over some number of years? Add up the annual AFR's or, more conservatively, the ARR's.

How MTBF is derived Drive specs are based on accelerated life testing. A population of 1000 or so drives are run flat out at a high temperature for about 30 days. MTBF is calculated from that.

Want to calculate AFR and ARR from MTBF yourself? $AFR = 1 - (EXP(-8760/MTBF))$ MTBF in hours & 8760 is the hours in a year. $ARR = AFR/0.6$ 0.6 is the fraction of returned drives with trouble found

The Storage Bits take AFR isn't perfect. Civilians will still draw the wrong conclusions, but at least they'll avoid the "200 year drive!" fallacy.

Disk drives are incredible. They work at nanometer accuracies while spinning 120 times a second. Next to a disk drive a \$35,000 Swiss watch has the precision of a pile driver.

30 years ago a 25,000 hour MTBF was a good thing - on a \$20k drive - and now you get a 500,000 hours MTBF on a \$60 drive, with 2000 times the capacity. Amazing.

If you back up your data you can keep your drives as long as you want. For critical apps I'd replace drives every three years.

Comments welcome, of course. The friendly folks at Seagate provided the formulas, but the conclusions are my own.

Topics: [Storage](#), [Hardware](#)



About Robin Harris

Robin Harris is Chief Analyst at TechnoQWAN LLC, based in Sedona, Arizona. He has over 30 years in the IT industry, including DEC and Sun, and degrees from Yale and the Wharton School.

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Talkback

RE: MTBF, AFR and you

Show me a driver that really gets 500,000 MTBF. The drive manufacturers have been inflating numbers each year for the last decade.

Of course since you mentioned Seagate, I always remember a consult when it was pointed out to them that their approach was going to guarantee failures on Windows, the Seagate's VP response was "No problem we will blame it on the OS"



oldsysprog

8 February, 2011 08:54

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RE: MTBF, AFR and you

@oldsysprog Let's face the facts, numbers are always inflated everyday if it benefits the person, business or corporation responsible for results. This is no different, I even do it in my own company offering <http://www.sniperwebconsulting.com> seo services kent. It's not lying it's just a slight tweak to make things seem more rosey.



toby juggles

20 September, 2011 00:37

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Lies, d*** lies, and statistics . . .

I'm not terribly fond of your pure statistical approach anymore. A lot of things can cause a failure, and it's not as simple as tossing stats around. While it is very true you should always back up your drives, it's also true that you can keep drives going for a long drive.

My own trio of 250 GB drives has lasted me quite a while, and while I do plan on upgrading to 1 TB drives (and maybe a solid state for the OS), I'm pretty impressed at how long they've lasted so far.

I do keep backups, of course, so having them go out isn't a problem, but I don't think it's raw luck that they've lasted so long. I've kept cold reboots to a minimum, and I keep a lot of RAM on my system so I'm not constantly using the disk. I've also stuck with the same model/manufacturer for them.

Statistics tell us *that* a certain percentage will fail within some given amount of time, but they don't tell us how or why they fail. In short, statistics aren't really the whole story.



CobraA1

8 February, 2011 10:04

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RE: MTBF, AFR and you

@CobraA1

It's a complex subject and we don't have all the data we'd like. The vendors track the data, but until the CMU & Google studies we didn't have any public data. And those studies are almost 4 years old.

But the CMU research found that workload doesn't affect drive life and that temperatures below 104F have little effect either. Google doesn't do a lot of reboots so we don't have any good data on how startups affect drive life.

To me the biggest issue is the NTF problem. Users don't send drives back for the fun of it, so where is the root cause analysis? Is the vendor test coverage insufficient? Are OS I/O stacks funkier than already know? Intermittent controller bugs? Or most likely, what combination of all 3?

The fact is that we still don't understand a large number of user-reported drive failures. And that is too bad.

Robin



Robin Harris

8 February, 2011 11:33

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RE: MTBF, AFR and you

@Robin Harris
I wonder if the NTF stats are the result of people returning drives that are truly dead....as in won't spin up. When submitting an RMA for these drives, there is no diagnostic code to enter from the diagnostic software that most drive manufacturers push out to potential RMA users. Do those default to NTF?

The diagnostic code is: "It's broke".



VRSpock

10 February, 2011 11:25

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RE: MTBF, AFR and you

If 60% is the NTF rate, why is ARR not $AFR / .4$? Seems like $AFR = ARR * (1 - .6)$.



dholland

8 February, 2011 10:27

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RE: MTBF, AFR and you

@dholland

You're right. 40% is the NTF rate. My mistake. Fixed.

Thanks!

Robin



Robin Harris

9 February, 2011 07:35

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RE: MTBF, AFR and you

Since AFR is obtained by PFM from MTBF, how can it be a better measure? You're just...massaging...numbers derived from the same basis.



Vesicant

10 February, 2011 07:22

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Not the entire picture

What about failures due to firmware issues (Seagate and Fujitsu come to mind)? Do the results calculate failures based on failing circuitry or just plain old programming screw-ups, or are they just predictions based on stats for motor failures?



Joe_Raby

10 February, 2011 07:37

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OMG...

...GTFOH!



james347

15 February, 2011 11:51

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RE: MTBF, AFR and you

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Quarizma

21 August, 2011 11:48

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RE: MTBF, AFR and you

Oh god... I can't follow. [>action forex](http://gainpips.com/action-forex-review)



pjlatombo

27 September, 2011 17:12

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