Hard Drive, SSD, NVMe Troubleshooting Flowchart

A guide to help you diagnose drive problems and recommended actions

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How to use

- This is very important, read and understand these pages before moving forward. This is only a troubleshooting guide and it will assist with diagnosing the most common situations seen. It is NOT a guide to fix every little problem that can arise from a file system issue, this is focused on physical drive issues. I did include some basic ZFS troubleshooting because many people think these problems are drive failures and this will identify if it is a drive failure or not.
- **You MUST be a privileged user** such as `root` or you may need to use `sudo`. If you enter a command and get the response that the command cannot be found, then you do not have the privileges to run that command.
- Often people see an error and jump to an incorrect conclusion, especially when experiencing ZFS errors. This guide will help reduce going down the wrong path.
- Refer to Appendix A for examples of Specific Measurable Achievable Relevant Time-bound (SMART) and Field Access Reliability Metrics (FARM) screen outputs and Appendix A also has Amplifying Information for the Chart questions.
- When an operation is requested, such as reading SMART data or performing a SCRUB, refer to Appendix B for what the command is and how to use the command. If you are uncomfortable doing this, then seek additional help.
- Seagate drives may (generally do) report Error Rates differently, it looks like a wild rapidly changing number. Be aware of this for Seagate drives.

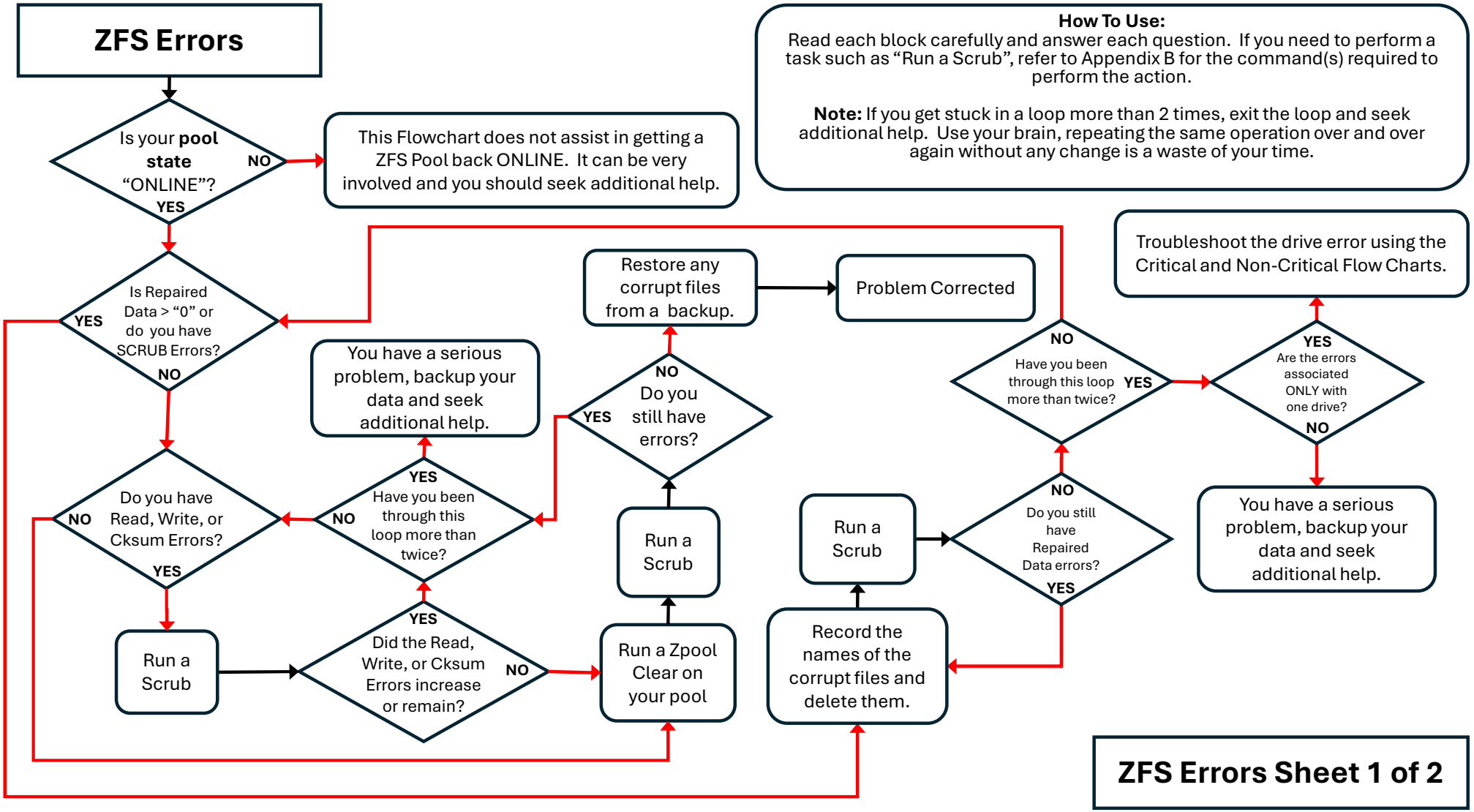
There are four flowcharts:

1. ZFS ERRORS
2. CRITICAL DRIVE ERRORS - This flowchart is for what the author considers critical errors.
3. NON-CRITICAL DRIVE ERRORS – This flowchart is for what the author considers are non-critical errors, however that doesn't mean they are to be ignored and pushed off. You still need to take action.
4. SUSPECT FOUL PLAY (ALTERED DRIVE DATA) – The Seagate Drive Issue Saga

If you have recommended changes, reach out to me. I will evaluate it and update if I agree. Sorry about a lot of the small font, I will probably rebuild this in the next few months. This does replace the Hard Drive Troubleshooting Guide Version 1. Version 2 will be out eventually and include this flowchart presentation.

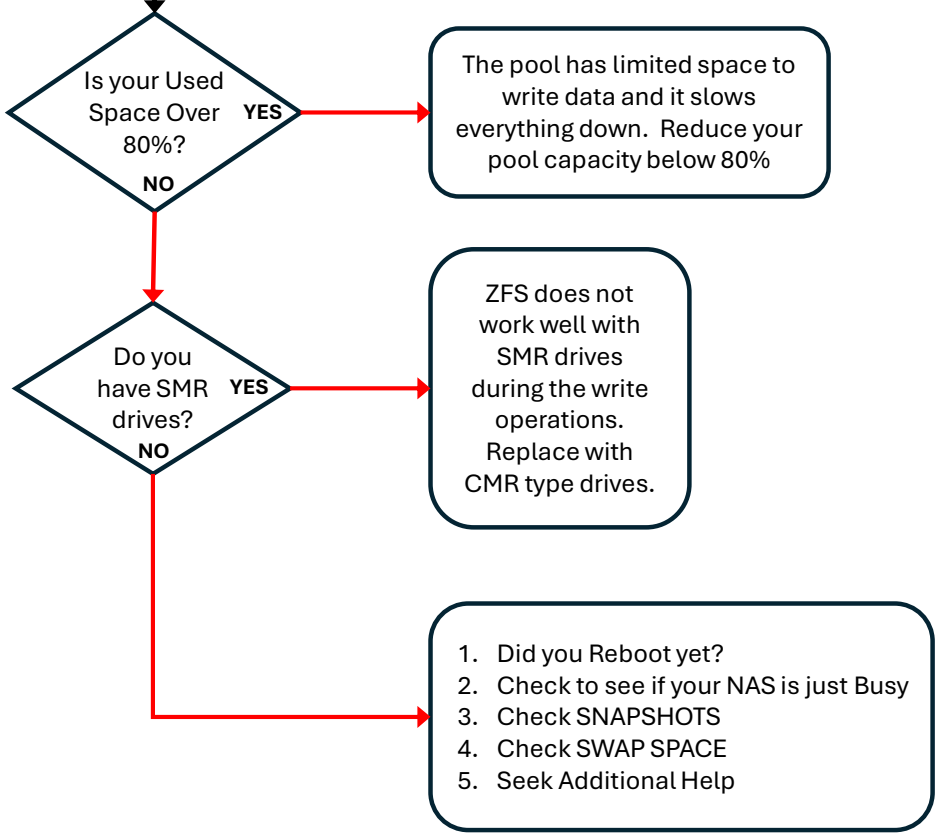
Hey Doc, How do I do something?

- This set of flowcharts is not designed to hold your hand and take you step by step to perform the troubleshooting, drive replacements, etc.
- Use the TrueNAS Guide to perform things like “How to replace a drive”. It is there and is well written.
- To check if you have an SMR drive, you need to play Detective on the internet and find out if your drive is SMR or CMR. If you have SMR, this could be your problem.
- These flowcharts will not help you put your pool back ONLINE. If your pool is ONLINE, then it will help with correcting the common ZFS problems seen, which many people attribute to a drive failure.
- Thank you @Alexey for your recommended changes.


ZFS Errors
How To Use:
Read each block carefully and answer each question. If you need to perform a task such as "Run a Scrub", refer to Appendix B for the command(s) required to perform the action.
Note: If you get stuck in a loop more than 2 times, exit the loop and seek additional help. Use your brain, repeating the same operation over and over again without any change is a waste of your time.
Is your pool state "ONLINE"?
NO
YES
This Flowchart does not assist in getting a ZFS Pool back ONLINE. It can be very involved and you should seek additional help.
Is Repaired Data > "0" or do you have SCRUB Errors?
YES
NO
Troubleshoot the drive error using the Critical and Non-Critical Flow Charts.
Restore any corrupt files from a backup.
Problem Corrected
NO
Have you been through this loop more than twice?
YES
YES
Are the errors associated ONLY with one drive?
NO
You have a serious problem, backup your data and seek additional help.
NO
Do you still have errors?
YES
You have a serious problem, backup your data and seek additional help.
Do you have Read, Write, or Cksum Errors?
NO
YES
YES
Have you been through this loop more than twice?
NO
Run a Scrub
NO
Do you still have Repaired Data errors?
YES
Run a Scrub
Run a Scrub
YES
Did the Read, Write, or Cksum Errors increase or remain?
NO
Run a Zpool Clear on your pool
Record the names of the corrupt files and delete them.
ZFS Errors Sheet 1 of 2

ZFS Slow Pool

(The pool is so slow today, what happened?)

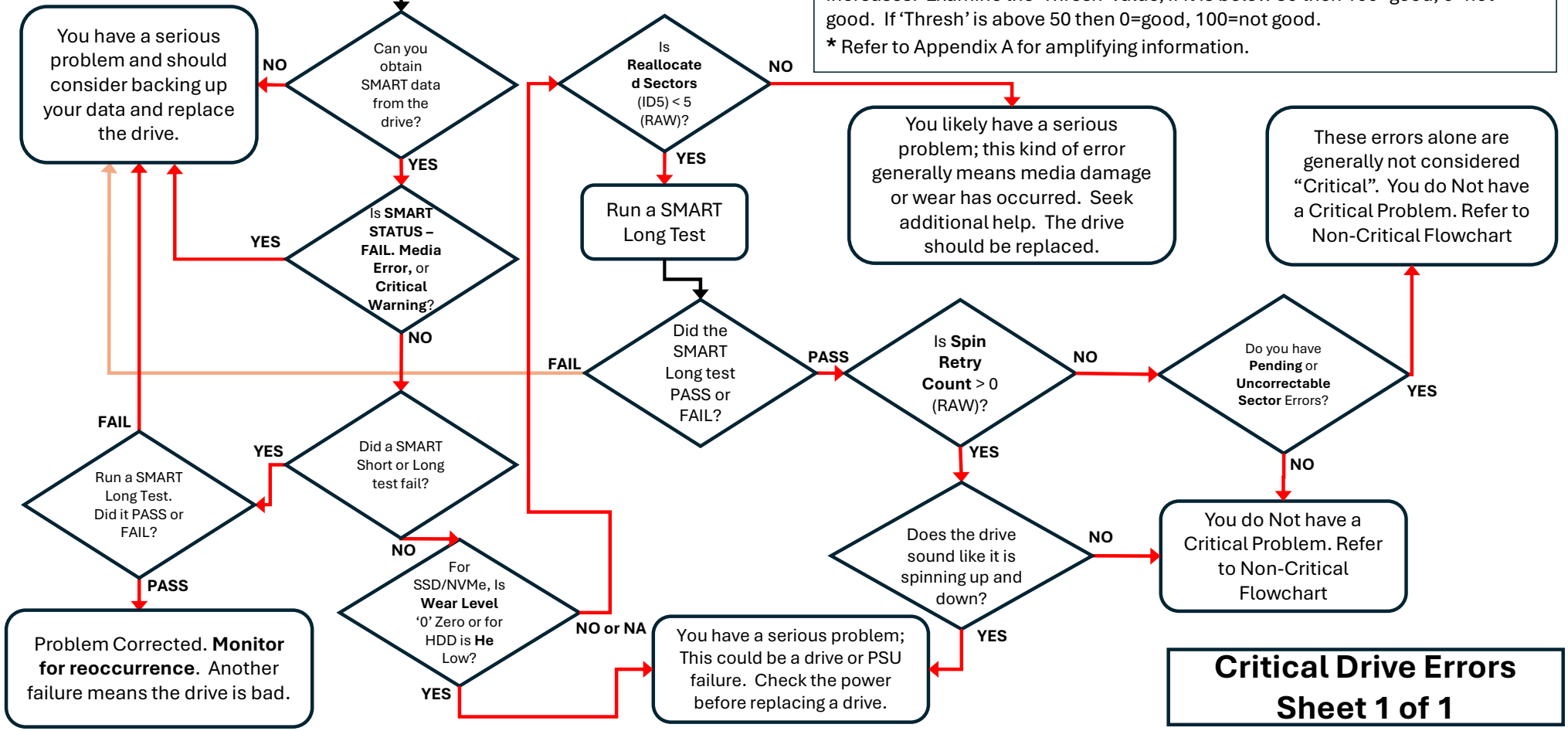


How To Use:
Read each block carefully and answer each question. If you need to perform a task such as “Run a Scrub”, refer to Appendix B for the command(s) required to perform the action.

ZFS Errors Sheet 2 of 2

Critical Drive Errors

NOTE:
NA = Not Applicable
Media Wear Level – Can be reported as 'Wear Level' or 'Percent Used'. Wear level typically starts at 100 and decreases, Percent Used typically starts at 0 and increases. Examine the 'Thresh' value, if it is below 50 then 100=good, 0=not good. If 'Thresh' is above 50 then 0=good, 100=not good.
* Refer to Appendix A for amplifying information.



Critical Drive Errors
Sheet 1 of 1

Non-Critical Drive Errors

Non-Critical Drive Errors
Sheet 1 of 2

Can you obtain SMART data from the drive?

NO → You have a serious problem, seek additional help.

YES → Are **UDMA CRC Errors** (ID 199) values increasing?

NO → * Are **Hardware ECC Recovered** or **MultiZone Errors** increasing and the **ONLY** errors?

YES → This is not an immediate issue, monitor for increasing counts. Hardware ECC Recovered count does not indicate a typical drive failure.

NO → Are there any other errors?

YES → To SHEET 2 connector

NO → Hardware ECC errors is the drive hardware automatically correcting the data read, like it should. MultiZone Error sometimes is an indicator of a problem, if associated errors exist, otherwise usually not an issue.

YES → Typically, this type of error is caused by a drive data cable issue. **Note the drive serial number**.

Power off, disconnect and reconnect the drive data cable, Power on. Does **the UDMA CRC** count continue to increase?

YES → Replace the suspect Data Cable. Does the **UDMA CRC** count continue to increase?

YES → Move the data cable to another port on the MB or HBA. Does the **UDMA CRC** count continue to increase?

YES → Physically **swap just the drive** with a known good drive. Does the problem follow the suspect drive?

New drive has UDMA errors now → You have an odd problem. Seek additional help. Consider replacing the HBA / MB.

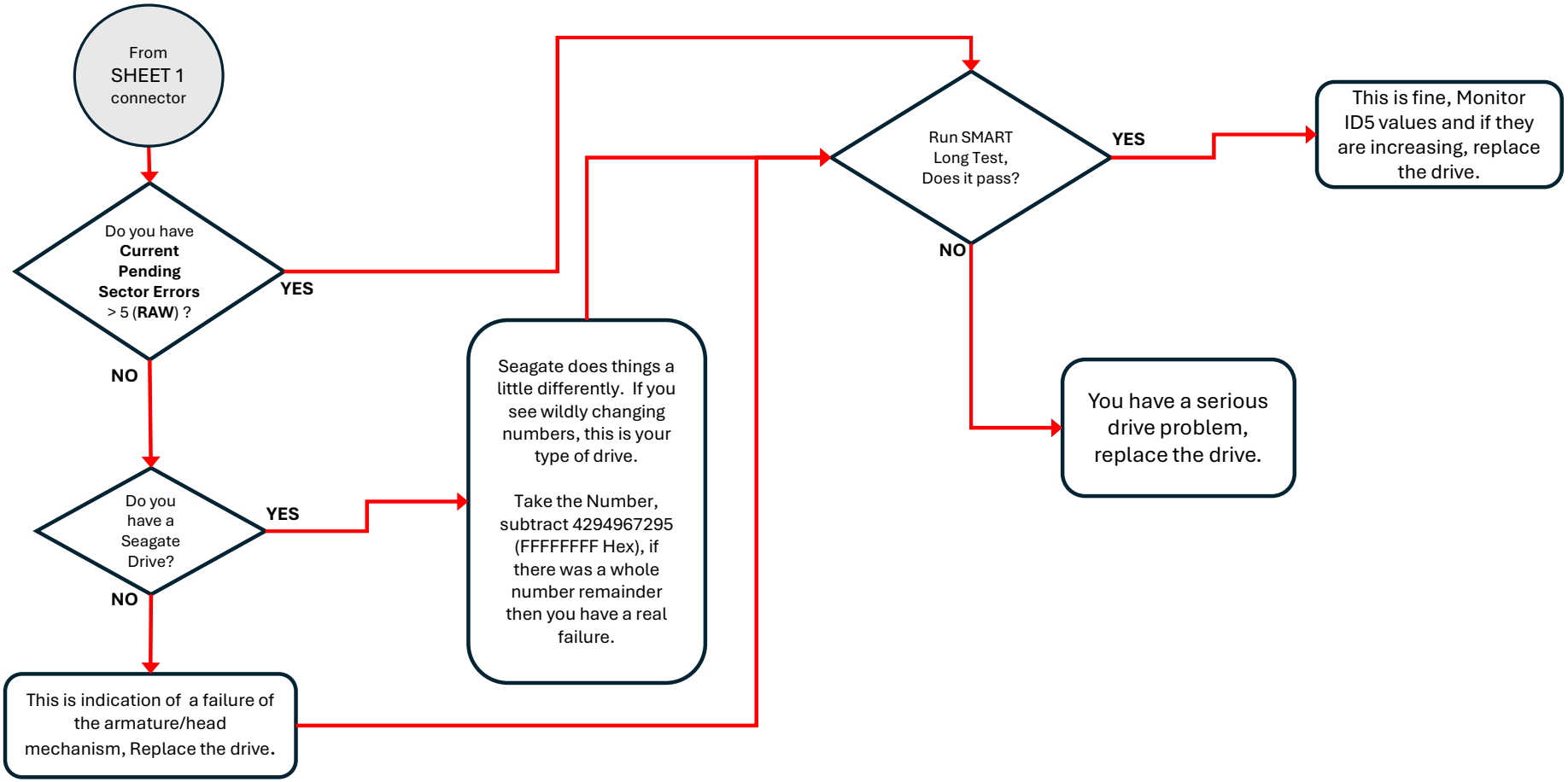
Stays with suspect drive → The drive appears to be faulty. This is generally not the typical outcome. Replace the drive.

NO → Problem Corrected. This count will never reduce, it lives with the drive for life. Monitor for reoccurrence. If problem returns, skip to previous question and answer Yes.

NO → Problem Corrected. This count will never reduce, it lives with the drive for life. Monitor for reoccurrence. If problem returns, skip to previous question and answer Yes.

NO → Problem Corrected. This count will never reduce, it lives with the drive for life. Monitor for reoccurrence. If problem returns, skip to previous question and answer Yes.

Non-Critical Drive Errors



Suspect Foul Play (Altered Drive Data)

With the flood of used Seagate hard drives in the market in 2024/2025, if you bought a new drive, you should verify that it is actually new. The steps to do that are here and I **Highly Recommend** you do this check. Unfortunately, only Seagate at this time has this FARM data so this will not work for other drive manufacturers. (Shameless Plug -- Multi-Report V3.15 (and later) has this check built-in.)

Procedure:

1. Check which version of smartmontools is installed. `smartctl`

Is smartmontools version 7.4 or greater?

NO

You will need smartmontools 7.4 or later to read the FARM data.

YES

Procedure:

2. OBTAIN SMART DRIVE DATA `smartctl –a /dev/driveid`
3. OBTAIN FARM DATA `smartctl –l /dev/driveid` (-l is a lower case L)
4. From both pieces of data, write down the following data:
   a. Serial Number
   b. Power On Hours
   c. Spindle Power On Hours
   d. Head Flight Hours
   e. LBAs Read and Written

Compare the data between the two reports, is there a discrepancy?

NO

You are one of the lucky ones, your drive appears to be valid.

YES

You Likely have an altered drive. Seek additional help.

Appendix A

How to read SMART Output and Amplifying Information

- SMART Data is not terribly difficult to read and understand. Below is a typical output for a Hard Drive. Not all look the same. Some will display different Attributes (some are manufacturer specific as well), the format may look significantly different for SAS drives.

- Whatever the format is of the SMART data, it will contain similar values, pay attention to what you are reading. More SMART info on the next page.

- If you have a question about an attribute, Google is your friend. Use “S.M.A.R.T.” and the attribute name.

Appendix A
How to read SMART Output and Amplifying Information

This is amplifying information to the troubleshooting flowcharts.

Read the entire flowchart section before jumping into it. You can wait 5 minutes to begin actual troubleshooting.

When reading SMART data, take in all of the data for the line you are reading. This is the ID, Attribute, VALUE, WORST, THRESH, RAW_VALUE. When reading SMART values, pay attention to what the flowchart is asking for.

- The ID/Attribute is the function you are examining.
- VALUE is a Normalized value on the performance of this attribute.
- WORST is the Normalized value at its worst value attained.
- THRESH is the Normalized value at which point the VALUE or WORST is considered a drive failure if they ever reach this value.
- RAW_VALUE is the non-normalized value. This value is used often for many of the attributes and may not be reflected immediately in the Normalized values.

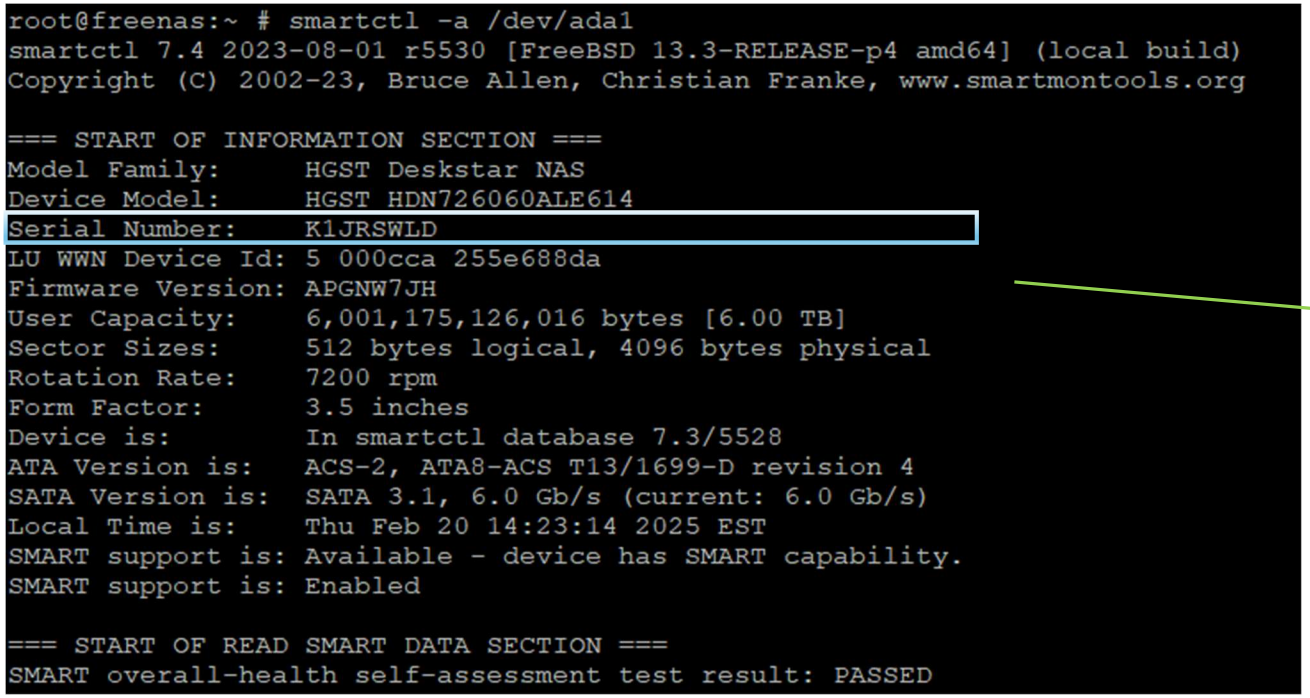
- When evaluating SMART data:
  - Example: ID195/Hardware ECC Recovered – VALUE=200, WORST=200, THRESH=0, RAW_VALUE=40945360 (data from my drive)

  When the VALUE or WORST approaches the THRESH value, this is typically a failing indication. In this case, if VALUE=45 and WORST=(45 or less), AND you have other errors, then this drive should be replaced at an opportune time.

  - Example: ID1/Raw Read Error Rate – VALUE=076, WORST=064, THRESH=006, RAW_VALUE=40945360 (familiar number?

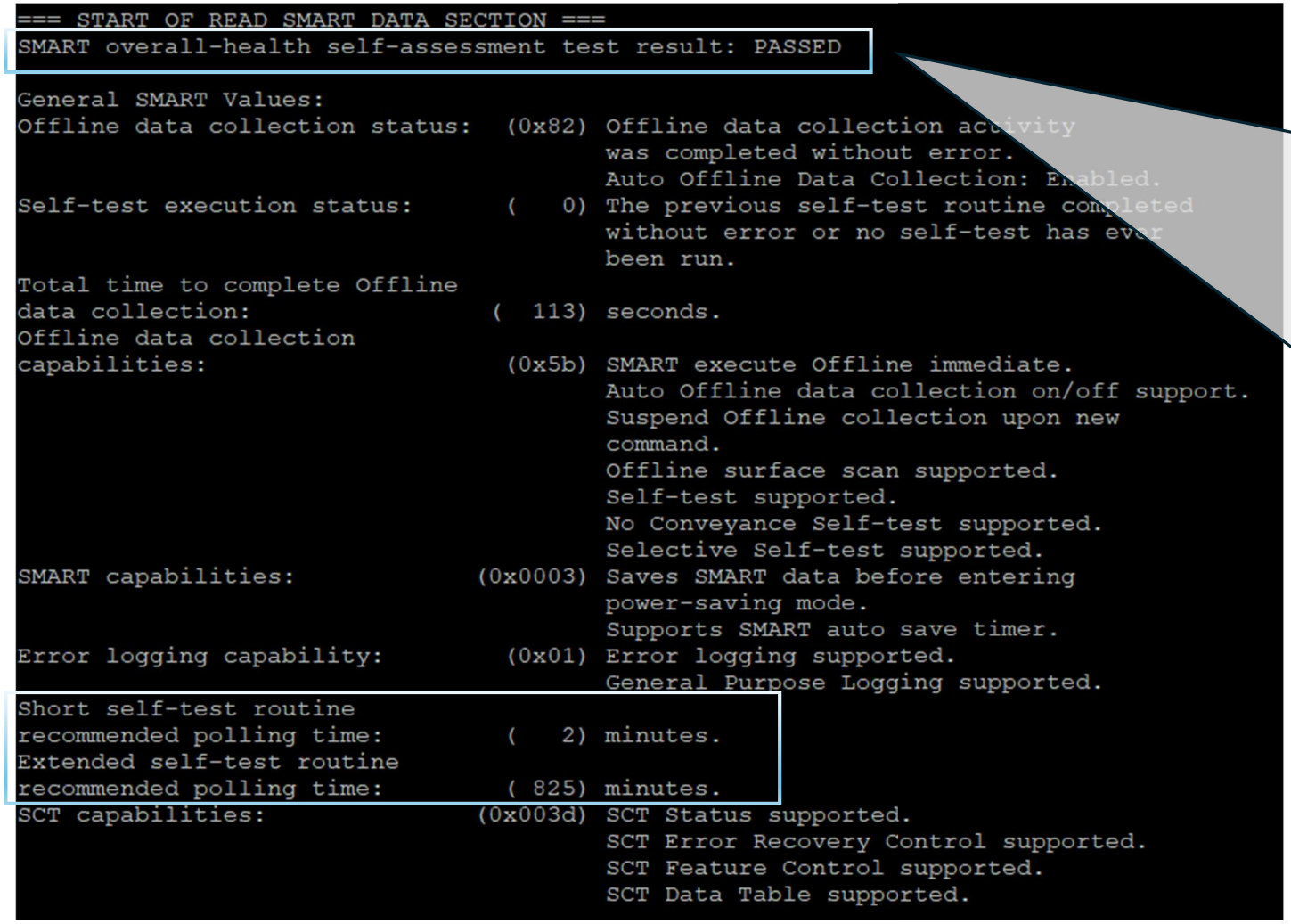
  Error rates change, they go down and they go up. In this example you can see that the error rate dropped to 064 but is not 076. Error rates are calculated over a large number of operations. Seagate drives display these large RAW_VALUE number as this value represents more than a total number of failures.

If you have a question about what you are reading, ask the question. No one wants you to replace a drive unless it is failing, and does not want you to ignore a drive that is failing.



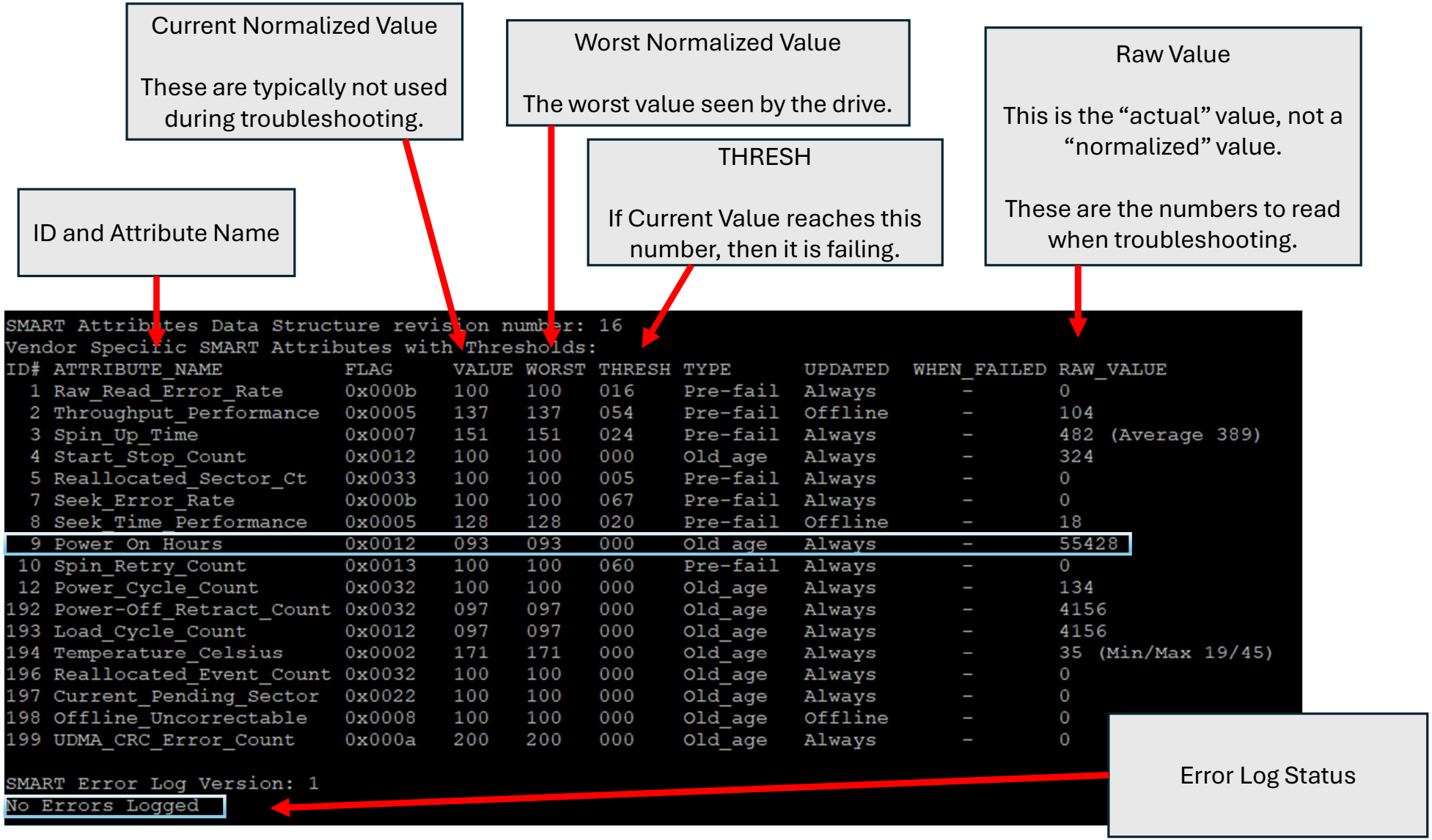
This provides manufacturer specific data. It also includes if SMART is supported or not.

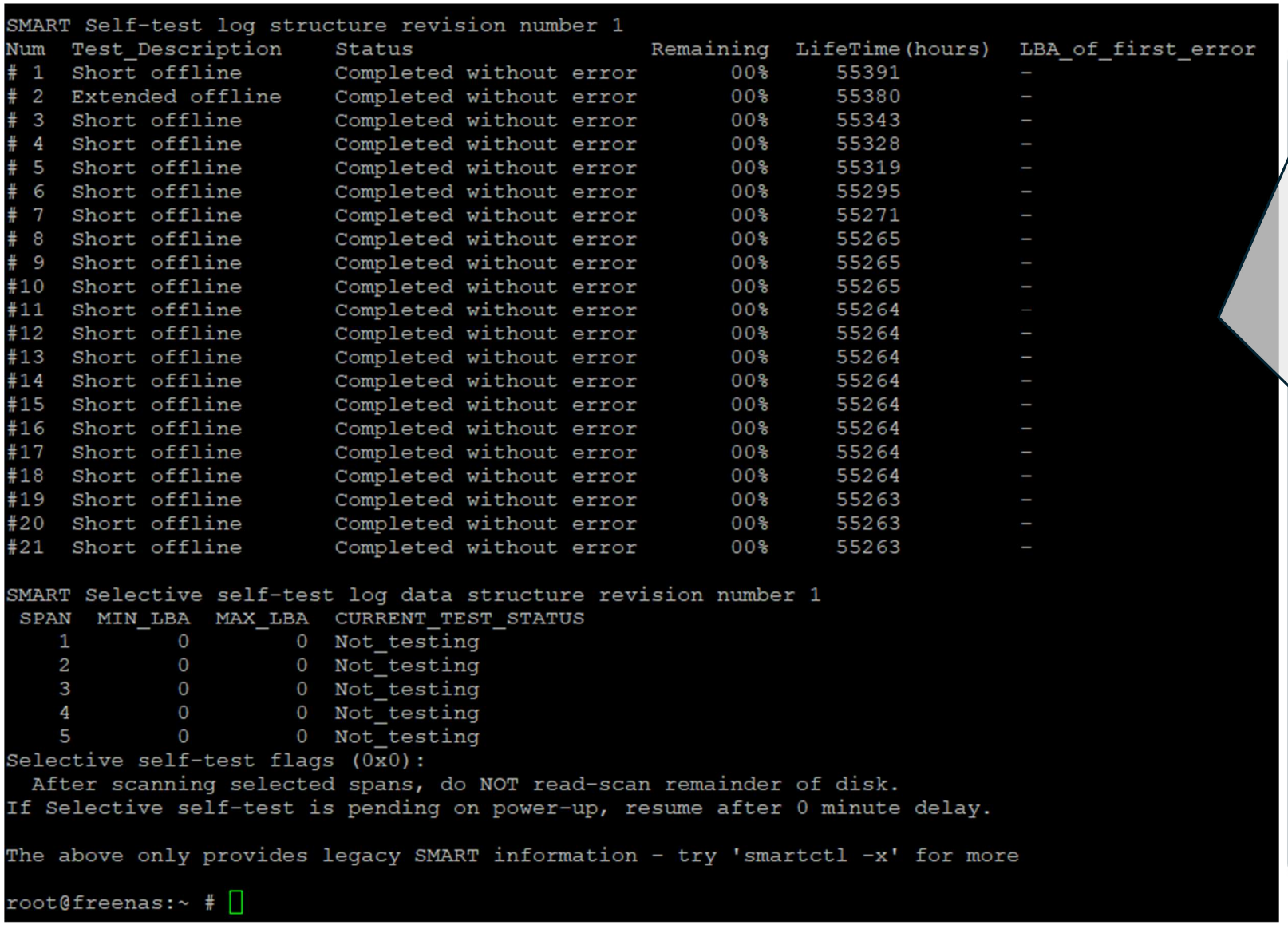
This is the typical location to obtain the drive serial number, which you will use to replace a drive, hint hint.



These two boxes show if the SMART drive power on self-tests PASSED or FAILED. A PASSED does not mean the drive is good. This is an assumption many people make which is very wrong.

The lower box identifies how long it takes for a ‘typical undisturbed’ SMART Short and Long test should take. Any drive activity (data access or scrub for example) slows this down as SMART testing has the lowest priority so it will take longer with drive activity.


Current Normalized Value
These are typically not used during troubleshooting.
Worst Normalized Value
The worst value seen by the drive.
THRESH
If Current Value reaches this number, then it is failing.
Raw Value
This is the “actual” value, not a “normalized” value.
These are the numbers to read when troubleshooting.
ID and Attribute Name
SMART Attributes Data Structure revision number: 16
Vendor Specific SMART Attributes with Thresholds:
ID# ATTRIBUTE_NAME FLAG VALUE WORST THRESH TYPE UPDATED WHEN_FAILED RAW_VALUE
1 Raw_Read_Error_Rate 0x000b 100 100 016 Pre-fail Always - 0
2 Throughput_Performance 0x0005 137 137 054 Pre-fail Offline - 104
3 Spin_Up_Time 0x0007 151 151 024 Pre-fail Always - 482 (Average 389)
4 Start_Stop_Count 0x0012 100 100 000 Old_age Always - 324
5 Reallocated_Sector_Ct 0x0033 100 100 005 Pre-fail Always - 0
7 Seek_Error_Rate 0x000b 100 100 067 Pre-fail Always - 0
8 Seek_Time_Performance 0x0005 128 128 020 Pre-fail Offline - 18
9 Power_On_Hours 0x0012 093 093 000 Old_age Always - 55428
10 Spin_Retry_Count 0x0013 100 100 060 Pre-fail Always - 0
12 Power_Cycle_Count 0x0032 100 100 000 Old_age Always - 134
192 Power-Off_Retract_Count 0x0032 097 097 000 Old_age Always - 4156
193 Load_Cycle_Count 0x0012 097 097 000 Old_age Always - 4156
194 Temperature_Celsius 0x0002 171 171 000 Old_age Always - 35 (Min/Max 19/45)
196 Reallocated_Event_Count 0x0032 100 100 000 Old_age Always - 0
197 Current_Pending_Sector 0x0022 100 100 000 Old_age Always - 0
198 Offline_Uncorrectable 0x0008 100 100 000 Old_age Offline - 0
199 UDMA_CRC_Error_Count 0x000a 200 200 000 Old_age Always - 0
SMART Error Log Version: 1
No Errors Logged
Error Log Status



```
SMART Self-test log structure revision number 1
Num  Test_Description    Status                  Remaining  LifeTime(hours)  LBA_of_first_error
# 1  Short offline       Completed without error       00%     55391         -
# 2  Extended offline    Completed without error       00%     55380         -
# 3  Short offline       Completed without error       00%     55343         -
# 4  Short offline       Completed without error       00%     55328         -
# 5  Short offline       Completed without error       00%     55319         -
# 6  Short offline       Completed without error       00%     55295         -
# 7  Short offline       Completed without error       00%     55271         -
# 8  Short offline       Completed without error       00%     55265         -
# 9  Short offline       Completed without error       00%     55265         -
#10  Short offline       Completed without error       00%     55265         -
#11  Short offline       Completed without error       00%     55264         -
#12  Short offline       Completed without error       00%     55264         -
#13  Short offline       Completed without error       00%     55264         -
#14  Short offline       Completed without error       00%     55264         -
#15  Short offline       Completed without error       00%     55264         -
#16  Short offline       Completed without error       00%     55264         -
#17  Short offline       Completed without error       00%     55264         -
#18  Short offline       Completed without error       00%     55264         -
#19  Short offline       Completed without error       00%     55263         -
#20  Short offline       Completed without error       00%     55263         -
#21  Short offline       Completed without error       00%     55263         -

SMART Selective self-test log data structure revision number 1
 SPAN  MIN_LBA  MAX_LBA  CURRENT_TEST_STATUS
    1        0        0  Not_testing
    2        0        0  Not_testing
    3        0        0  Not_testing
    4        0        0  Not_testing
    5        0        0  Not_testing
Selective self-test flags (0x0):
  After scanning selected spans, do NOT read-scan remainder of disk.
If Selective self-test is pending on power-up, resume after 0 minute delay.

The above only provides legacy SMART information - try 'smartctl -x' for more

root@freenas:~ #
```

SMART Self-test Results

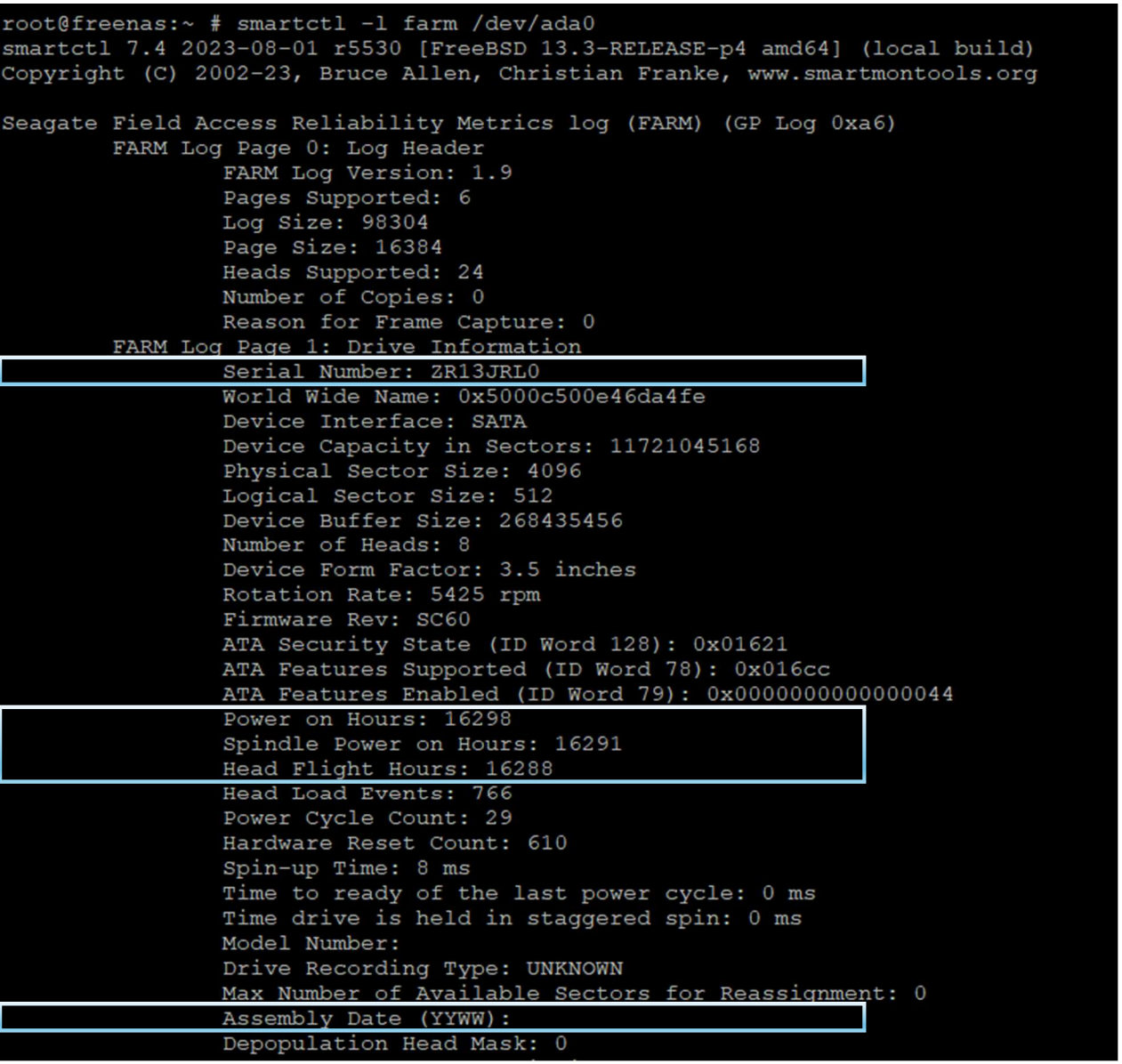
This is a list of the most recent SMART self-tests and the results.

It lists what type of SMART test was performed, if it completed without error, Failed, or Aborted.

If a test is in progress, you will see how much if the test remains.

When the test completes/fails/aborts, the Power On Hours value is recorded so you known when this test occurred.
(note: I have tested this drive a lot for script development hence the multiple entries for the same hour.)

And if there is a failure, typically you will see a number which identifies the LBA (Logical Block Address) where the failure occurred. There is likely problems right after that LBA as well, it is rarely one minor bad spot.



FARM Results

This is a list of the FARM results on a Seagate drive (currently only supported by Seagate).

Items to note are:
Serial Number:
Power on Hours:
Spindle Power on Hours:
Head Flight Hours:
Assembly Date: (if provided)

Compare to the SMART data:

1. Serial Number and Power on Hours
2. Spindle Power On Hours and Head Flight Hours should be reasonably close to Power On Hours, especially for a new drive, unless you Sleep the drive a lot. Reasonable for a new drive would be less than 100 hours (should be closer to almost zero).
3. Assembly Date, if provided should match. My drive does not have this data.

APPENDIX B

COMMANDS TO HELP YOU

Below is a list of common commands for both CORE (FreeBSD) and SCALE (Debian) which help diagnose the possible drive issue. Unless specifically identified as CORE or SCALE, the commands work for both. These commands are used in the troubleshooting procedures. Some commands can be dangerous and I will bold those in RED font. But can be simply means, don't misuse the command, and be very precise and press the correct keys.

FORMAT: Each command will be surrounded by an apostrophe (`), the same way we post commands on the TrueNAS Forum. Blue Font represents the name of your pool, so replace pool with the name of your pool. Orange font indicates your Drive Ident. Green font is Extra Information.

SAFETY OF COMMANDS: These commands are all safe to use as outlined below. Some of the commands have do have destructive power, however you would have to **significantly** deviate from the examples provided.

ZPOOL COMMANDS

`zpool status -v`	Provides the pool status for all pools.
`zpool scrub pool`	Starts a SCRUB operation on the selected pool.
`zpool clear pool `	Clears all Read, Write, and Chsum errors for the designated pool.

IDENTIFY DRIVE BY GPTID or DRIVE IDENT

Note: Drives may have multiple partitions so when cross referencing by GPTID, you just need to look for a Drive ID, not the different partitions. Drive ada0p1 is the same physical drive as ada0p2.

Example "gptid/d0f8a4fe-bf79-11ed-a0df-000c296fd555 N/A ada0p2" This is Drive ID ada0 partition 2.

`lsblk -o +PARTUUID,NAME,LABEL,SERIAL`	[SCALE]: Provides a listing of your disks, partitions, drive ident, and drive serial numbers so you can cross reference all these identifying areas so you replace the correct drive using the serial number.
`glabel status`	[CORE]: Provides the GPTID and Drive Ident. "nvd0" = "nvme0" To obtain the Drive Serial Number, use the "OBTAIN DRIVE SMART DATA" section to cross reference the DRIVE IDENT to the DRIVE SERIAL NUMBER.

OBTAIN DRIVE SMART DATA INFERFACE

`smartctl --scan`	[CORE/SCALE]: Lists the interface types for all available drive. If running the smartctl commands below, there is an error reading the drive, try adding the interface type. Format: `smartctl -d interface_type command string` Example: `smartctl -d scsi -a /dev/sda`

OBTAIN DRIVE SMART DATA

`smartctl -a /dev/sda`	[SCALE]: Provides a BASIC listing of the drive SMART data. Most diagnosis can be made using this data. The Orange indicates the Drive Ident.
`smartctl -a /dev/da0` or `ada0`	[CORE]: Same as above.
`smartctl -x /dev/sda`	[SCALE]: Provides EXTENDED listing of the drive SMART data.
`smartctl -x /dev/da0` or `ada0`	[CORE]: Same as above.

OBTAIN DRIVE FARM DATA

`smartclt -l farm /dev/sda`	[SCALE]: Provides Field Access Reliability Metrics log 'FARM'. This data can be useful in determining if a drive has had the SMART data reset.
`smartclt -l farm /dev/da0` or `ada0`	[CORE]: Same as above.

START/STOP A SMART TEST (HDD/SSD/Most NVMe)

SHORT TEST

`smartctl -t short /dev/sda`	[SCALE]: Run a "short" SMART test on the drive.
`smartctl -t short /dev/da0` or `ada0`	[CORE]: Same as above.

LONG TEST

`smartctl -t long /dev/sda`	[SCALE]: Run a "long" SMART test on the drive.
`smartctl -t long /dev/da0` or `ada0`	[CORE]: Same as above.

STOP TEST

`smartctl -X /dev/sda`	[SCALE]: This will abort the current SMART test if one is running.
`smartctl -X /dev/da0` or `ada0`	[CORE]: Same as above.

START/STOP a SMART TEST (NVME UNIQUE, IF SMARTCTL DOES NOT WORK)

These commands if misused could be destructive, enter as written.

SHORT TEST

`nvme device-self-test /dev/nvme0 -s 1`	[SCALE]: Run a “short” SMART test on the drive.
`nvmecontrol selftest -c 1 nvme0`	[CORE]: Same as above.

LONG TEST

`nvme device-self-test /dev/nvme0 -s 2`	[SCALE]: Run a “long” SMART test on the drive.
`nvmecontrol selftest -c 2 nvme0`	[CORE]: Same as above.

STOP SMART TEST

`nvme device-self-test /dev/nvme0 -s 0xf`	[SCALE]: This will abort the current SMART test if one is running.
`nvmecontrol selftest -c 0xf nvme0`	[CORE]: Same as above.