

# Hard Drive, SSD, NVMe Troubleshooting Flowchart

A guide to help you diagnose drive problems and recommended actions

By Joe Schmuck

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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.
- 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.
- 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.
- Refer to Appendix A for examples of Specific Measurable Achievable Relevant Time-bound (SMART) and Field Access Reliability Metrics (FARM) screen outputs.

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.

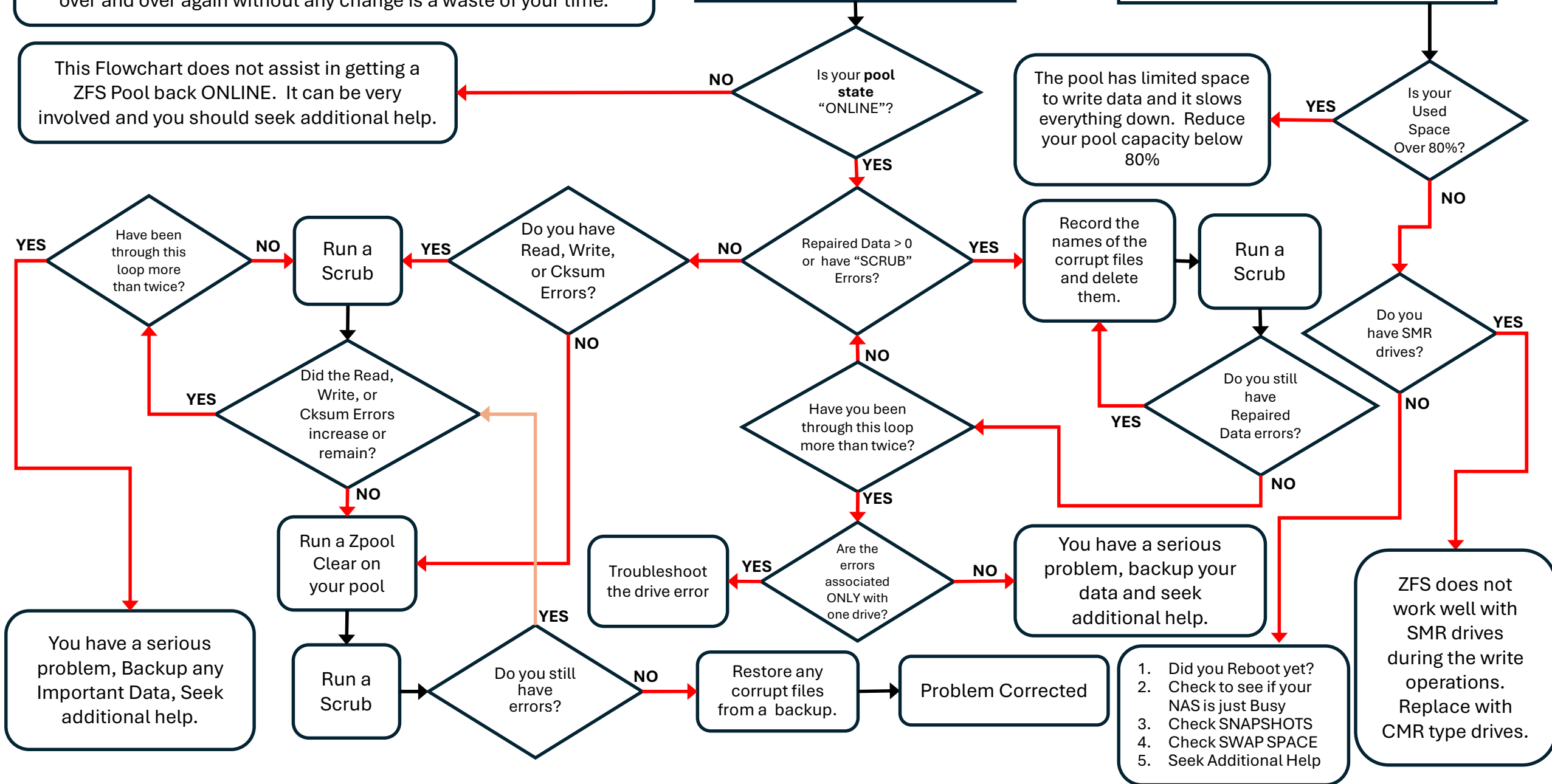
**Note:** If you get stuck in a loop more than 2 times, exit the loop and seek additional help. Use your brain, repeating the same operation over and over again without any change is a waste of your time.

This Flowchart does not assist in getting a ZFS Pool back ONLINE. It can be very involved and you should seek additional help.

## ZFS Errors

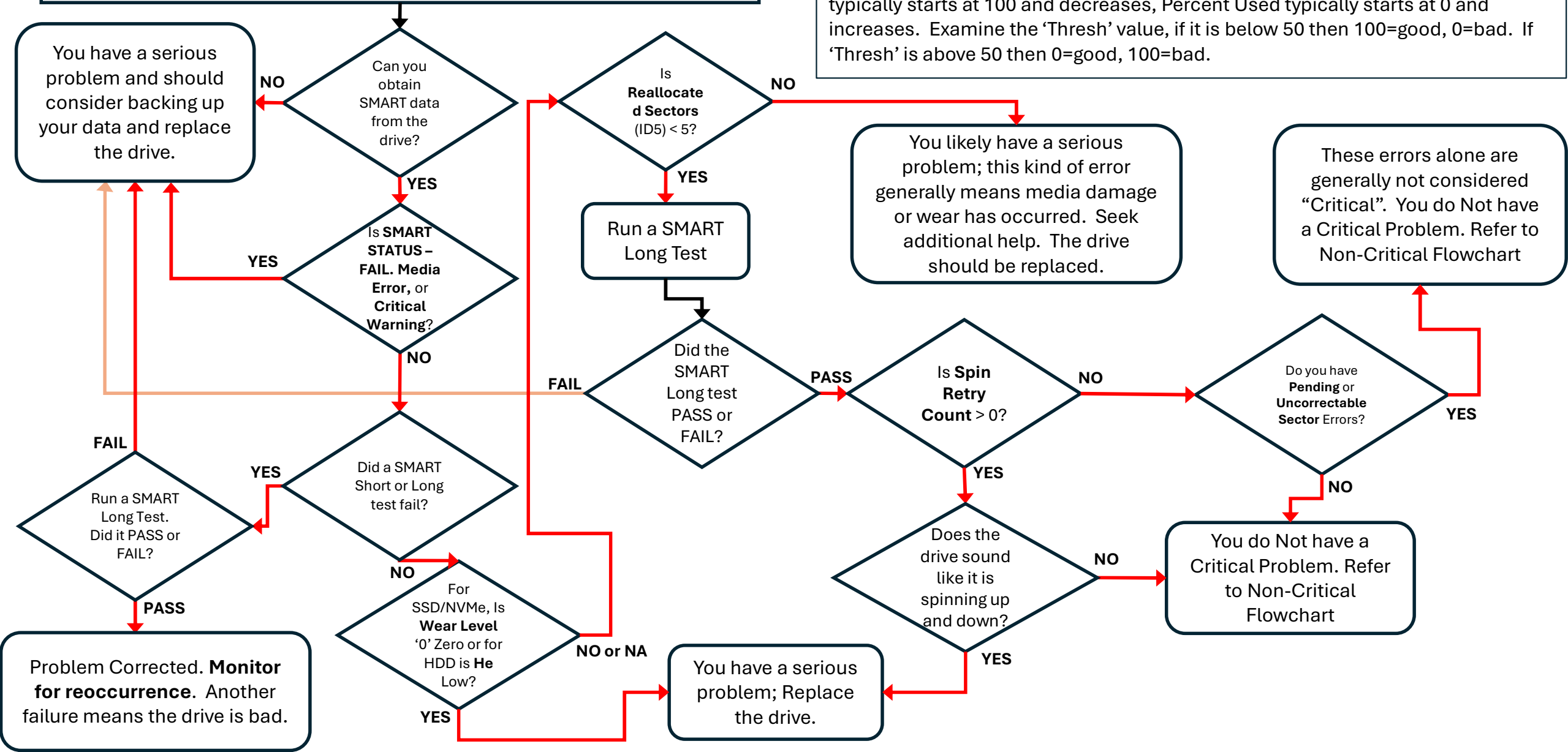
## Slow Pool

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

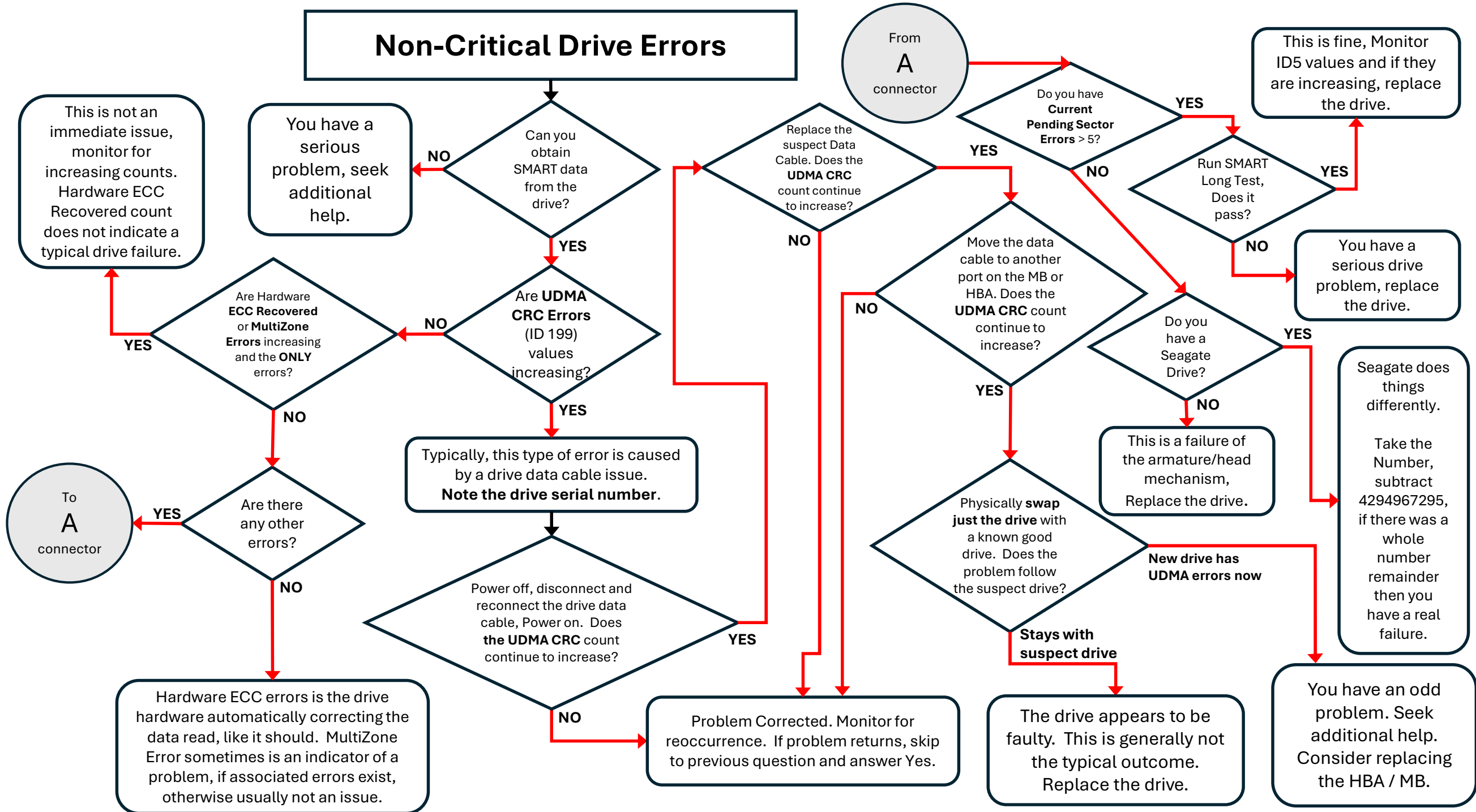


# Critical Drive Errors

**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=bad. If ‘Thresh’ is above 50 then 0=good, 100=bad.



# 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 has this check built-in.)

Procedure:

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

NO

Is  
smartmontools  
version 7.4 or  
greater?

YES

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

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

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

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

```
root@freenas:~ # smartctl -a /dev/ada1
smartctl 7.4 2023-08-01 r5530 [FreeBSD 13.3-RELEASE-p4 amd64] (local build)
Copyright (C) 2002-23, Bruce Allen, Christian Franke, www.smartmontools.org

=== START OF INFORMATION SECTION ===
Model Family:      HGST Deskstar NAS
Device Model:      HGST HDN726060ALE614
Serial Number:     K1JRSWLD
LU WWN Device Id:  5 000cca 255e688da
Firmware Version:  APGNW7JH
User Capacity:     6,001,175,126,016 bytes [6.00 TB]
Sector Sizes:     512 bytes logical, 4096 bytes physical
Rotation Rate:    7200 rpm
Form Factor:      3.5 inches
Device is:        In smartctl database 7.3/5528
ATA Version is:   ACS-2, ATA8-ACS T13/1699-D revision 4
SATA Version is:  SATA 3.1, 6.0 Gb/s (current: 6.0 Gb/s)
Local Time is:    Thu Feb 20 14:23:14 2025 EST
SMART support is: Available - device has SMART capability.
SMART support is: Enabled

=== START OF READ SMART DATA SECTION ===
SMART overall-health self-assessment test result: PASSED
```

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.



```
=== START OF READ SMART DATA SECTION ===
```

```
SMART overall-health self-assessment test result: PASSED
```

```
General SMART Values:
```

```
Offline data collection status: (0x82) Offline data collection activity  
was completed without error.  
Auto Offline Data Collection: Enabled.
```

```
Self-test execution status: ( 0) The previous self-test routine completed  
without error or no self-test has ever  
been run.
```

```
Total time to complete Offline  
data collection: ( 113) seconds.
```

```
Offline data collection  
capabilities: (0x5b) SMART execute Offline immediate.  
Auto Offline data collection on/off support.  
Suspend Offline collection upon new  
command.  
Offline surface scan supported.  
Self-test supported.  
No Conveyance Self-test supported.  
Selective Self-test supported.
```

```
SMART capabilities: (0x0003) Saves SMART data before entering  
power-saving mode.  
Supports SMART auto save timer.
```

```
Error logging capability: (0x01) Error logging supported.  
General Purpose Logging supported.
```

```
Short self-test routine  
recommended polling time: ( 2) minutes.
```

```
Extended self-test routine  
recommended polling time: ( 825) minutes.
```

```
SCT capabilities: (0x003d) SCT Status supported.  
SCT Error Recovery Control supported.  
SCT Feature Control supported.  
SCT Data Table supported.
```

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.

Raw Value

This is the “actual” value, not a “normalized” value.

THRESH

If Current Value reaches this number, then it is failing.

ID and Attribute Name

These are the numbers to read when troubleshooting.

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 know 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.

```
root@freenas:~ # smartctl -l farm /dev/ada0
smartctl 7.4 2023-08-01 r5530 [FreeBSD 13.3-RELEASE-p4 amd64] (local build)
Copyright (C) 2002-23, Bruce Allen, Christian Franke, www.smartmontools.org
```

```
Seagate Field Access Reliability Metrics log (FARM) (GP Log 0xa6)
```

```
FARM Log Page 0: Log Header
```

```
FARM Log Version: 1.9
```

```
Pages Supported: 6
```

```
Log Size: 98304
```

```
Page Size: 16384
```

```
Heads Supported: 24
```

```
Number of Copies: 0
```

```
Reason for Frame Capture: 0
```

```
FARM Log Page 1: Drive Information
```

```
Serial Number: ZR13JRL0
```

```
World Wide Name: 0x5000c500e46da4fe
```

```
Device Interface: SATA
```

```
Device Capacity in Sectors: 11721045168
```

```
Physical Sector Size: 4096
```

```
Logical Sector Size: 512
```

```
Device Buffer Size: 268435456
```

```
Number of Heads: 8
```

```
Device Form Factor: 3.5 inches
```

```
Rotation Rate: 5425 rpm
```

```
Firmware Rev: SC60
```

```
ATA Security State (ID Word 128): 0x01621
```

```
ATA Features Supported (ID Word 78): 0x016cc
```

```
ATA Features Enabled (ID Word 79): 0x00000000000000044
```

```
Power on Hours: 16298
```

```
Spindle Power on Hours: 16291
```

```
Head Flight Hours: 16288
```

```
Head Load Events: 766
```

```
Power Cycle Count: 29
```

```
Hardware Reset Count: 610
```

```
Spin-up Time: 8 ms
```

```
Time to ready of the last power cycle: 0 ms
```

```
Time drive is held in staggered spin: 0 ms
```

```
Model Number:
```

```
Drive Recording Type: UNKNOWN
```

```
Max Number of Available Sectors for Reassignment: 0
```

```
Assembly Date (YYWW):
```

```
Depopulation Head Mask: 0
```

## 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

- |                                 |   |
|---------------------------------|---|
| <code>`zpool status -v`</code>  | Provides the pool status for all pools.                           |
| <code>`zpool scrub pool`</code> | Starts a SCRUB operation on the selected pool.                    |
| <code>`zpool clear pool`</code> | 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 INTERFACE

``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

``smartctl -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.

``smartctl -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.