

# 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 a troubleshooting guide for the most common problems.** 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. Pay attention to the little things that catch your eye, as said, not everything is in these flowcharts but I tried to include the most common seen problems.
- **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.
- **Refer to Appendix A** for examples of Self-Monitoring, Analysis, and Reporting Technology (SMART) and Field Access Reliability Metrics (FARM) screen outputs and Appendix A also has Amplifying Information for the Chart questions.
- **Refer to Appendix B** when an operation is requested, such as reading SMART data or performing a SCRUB, for what the command is and how to use the command. If you are uncomfortable executing any of the commands, 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.
- 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 by using a more systematic approach.
- Values I used for Good/Bad evaluations are my personal values that I go by, not some industry standard. Example: “ID5 < 5” means this is my personal value where I allow a few reallocated sectors but when it becomes greater than 5, I replace the drive before complete failure. Some people may prefer a value of 1 as a failure, a value of 1 to me means to keep a watch on the value, if it starts to increase then that is a problem.

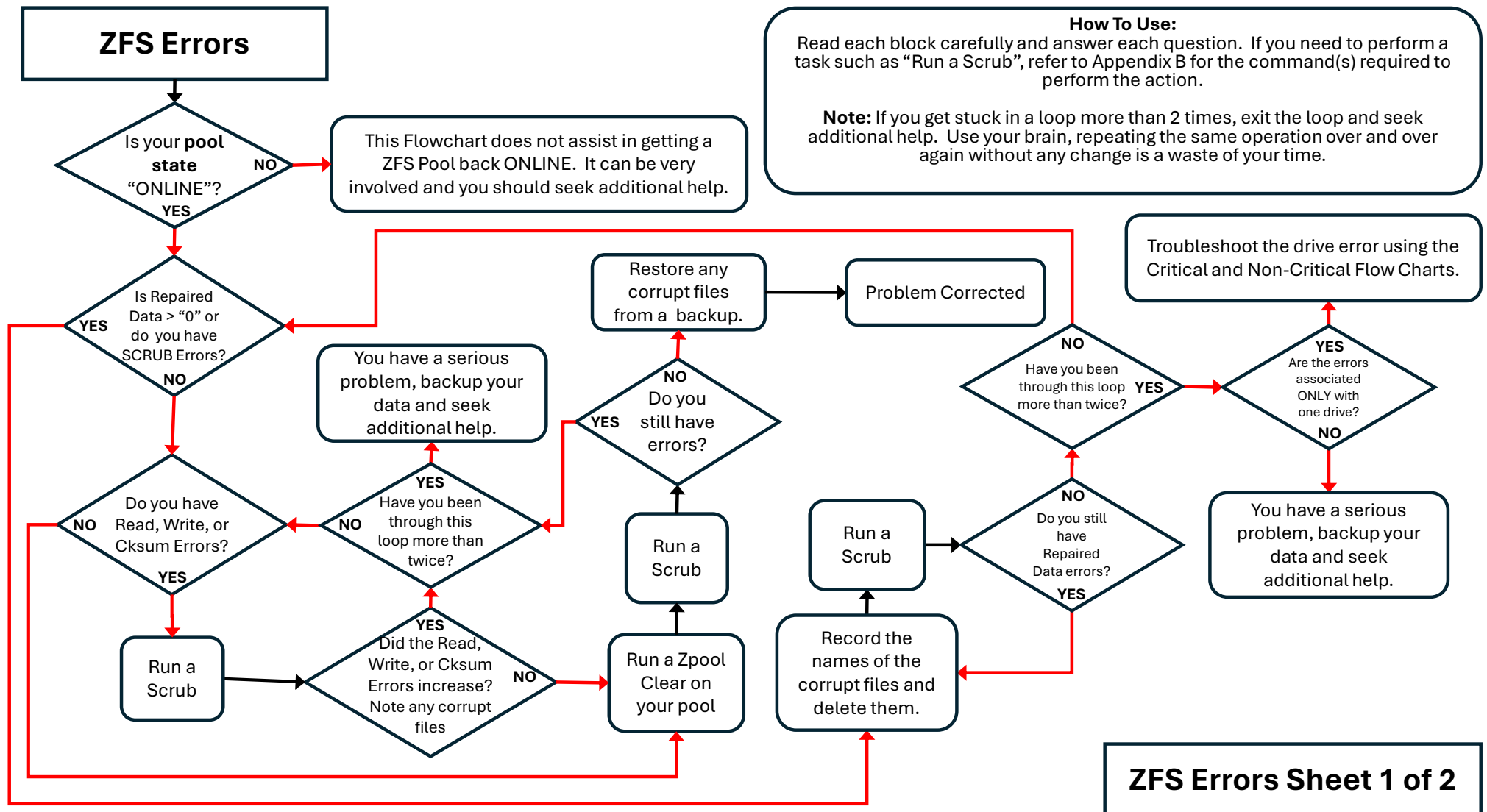
There are four flowcharts:

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 (Not only a Seagate issue)

# Hey Doc, How do I do something?

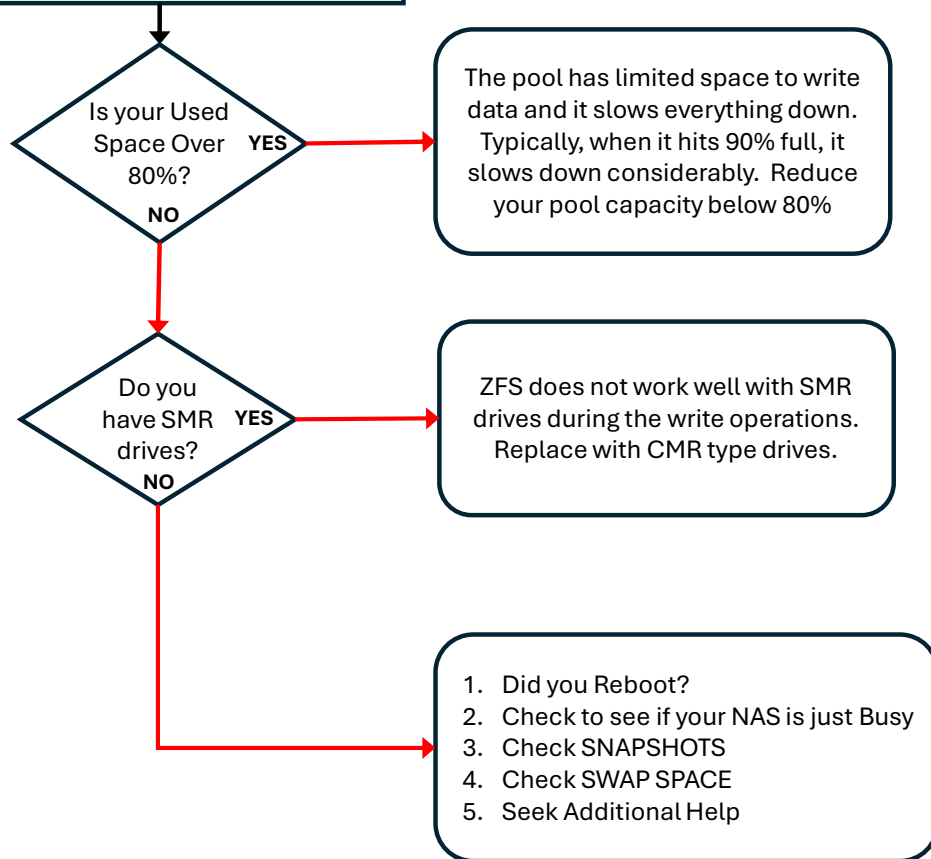
- This set of flowcharts is not designed to hold your hand and take you step by step to perform the troubleshooting, drive replacements, etc.
- Use the TrueNAS Guide to perform things like “How to replace a drive”. It is there and is well written.
- To check if you have an SMR drive, you need to play 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.
- If you need help, post the entire output of ``smartctl -x /dev/???'`` for interpretation. Do not hold back any data (serial number exception), thinking you know better. No one like to ask for data more than once.
- If you have recommended changes, reach out to me. I will evaluate it and update if I agree.
- Thank you @Alexey for your recommended changes.

## ZFS Errors



## 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.

**This flowchart is for pools which previously worked faster and have a noticeable slowdown.**

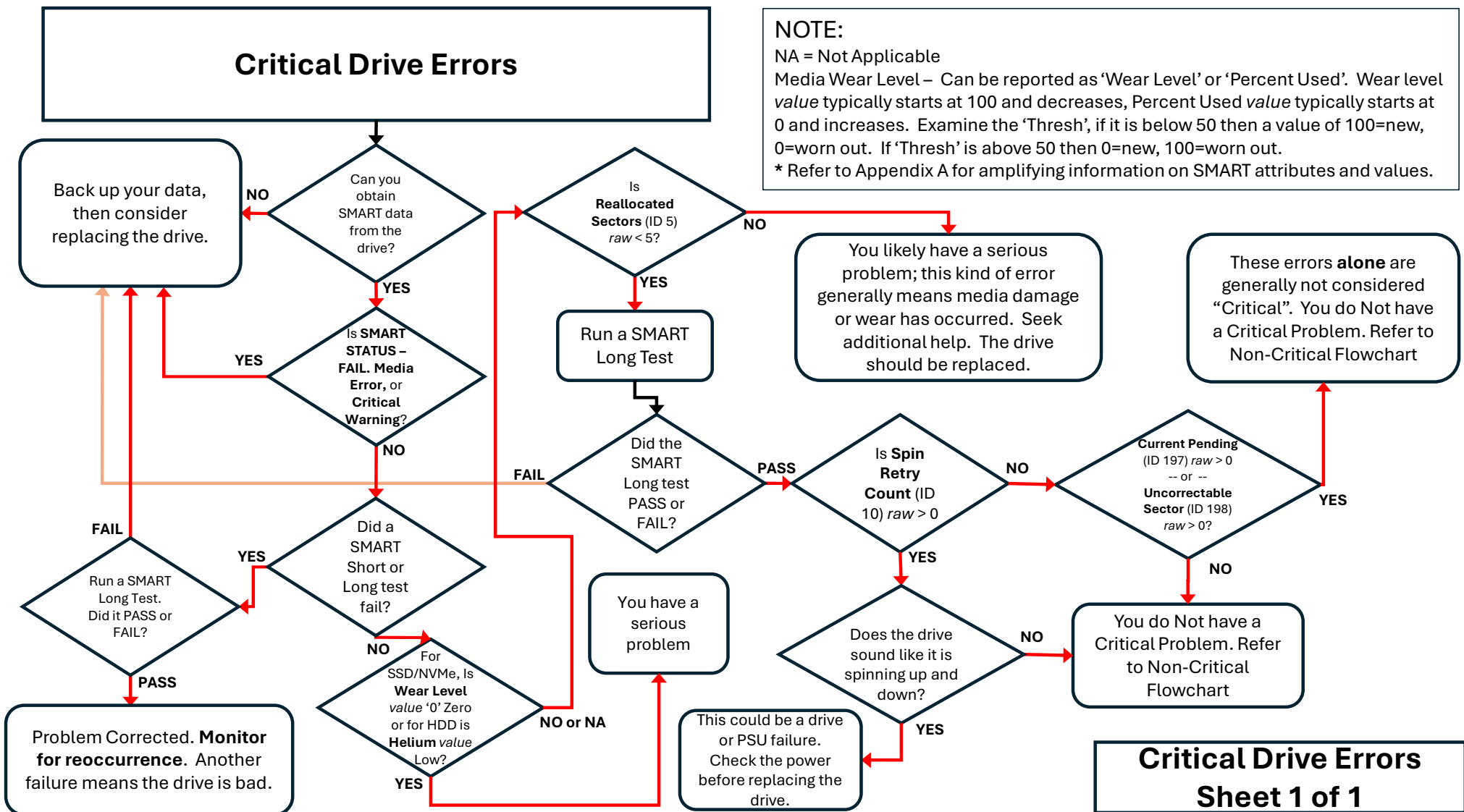
# Critical Drive Errors

## NOTE:

NA = Not Applicable

Media Wear Level – Can be reported as ‘Wear Level’ or ‘Percent Used’. Wear level *value* typically starts at 100 and decreases, Percent Used *value* typically starts at 0 and increases. Examine the ‘Thresh’, if it is below 50 then a value of 100=new, 0=worn out. If ‘Thresh’ is above 50 then 0=new, 100=worn out.

\* Refer to Appendix A for amplifying information on SMART attributes and values.



## Non-Critical Drive Errors

## Non-Critical Drive Errors Sheet 1 of 2

This is not an immediate issue, monitor for increasing counts.  
**Hardware ECC Recovered** (ID 195) *raw* count does not indicate a typical drive failure.

You have a serious problem, seek additional help.

Can you obtain SMART data from the drive?

NO

YES

Replace the suspect Data Cable. Does the **UDMA CRC Errors** (ID 199) *raw* continue to increase?

YES

NO

Move the data cable to another port on the MB or HBA. Does the **UDMA CRC Errors** (ID 199) *raw* continue to increase?

YES

NO

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

Stays with suspect drive

New drive has UDMA errors now

You have an odd problem. Seek additional help. Consider replacing the HBA / MB.

The drive appears to be faulty. This is generally not the typical outcome. Replace the drive.

Problem Corrected. The *raw* count will never decrease, it lives with the drive for life. Monitor for reoccurrence. If problem returns, skip to previous question and answer 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 **UDMA CRC** (ID 199) *raw* continue to increase?

YES

NO

Is **UDMA CRC Errors** (ID 199) *raw* increasing?

YES

NO

\* Are **Hardware ECC Recovered** or **MultiZone Errors** increasing and the **ONLY** errors?

NO

YES

Are there any other errors?

NO

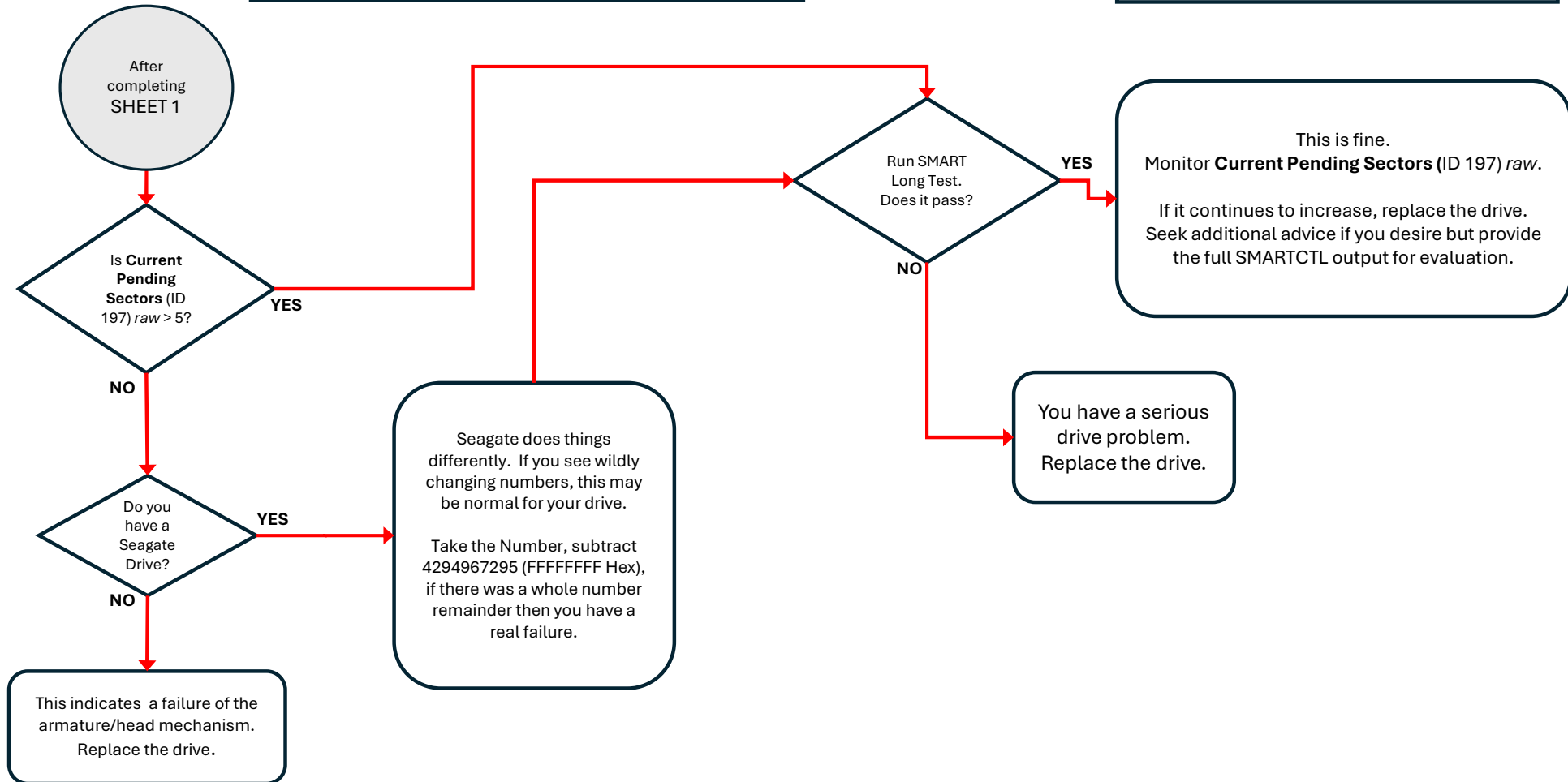
YES

Proceed to SHEET 2

**Hardware ECC Recovered** (ID 195) is the drive hardware automatically correcting the data read, as it should. **MultiZone Error** (ID 200) sometimes is an indicator of a problem, if associated errors exist, otherwise usually not an issue.

## Non-Critical Drive Errors

## Non-Critical Drive Errors Sheet 2 of 2





## Suspect Foul Play (Altered Drive Data)

With the flood of used Seagate and other brand 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. Western Digital has WDDA however that may not be more than exactly what is in SMART already and is not covered here as it required additional software that is not installed on TrueNAS.

(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

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
  - e. LBAs Read and Written

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

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

NO

YES

You Likely have an altered  
drive. Seek additional help.

## Appendix A

# How to read SMART Output and Amplifying Information

- The attribute is defined by its ID number. The human-readable name (e.g. “Reallocated Sectors Count” for ID 5) may vary slightly depending on the software you use.
- SATA HDDs, SAS HDDs, SATA SSDs, and NVMe SSDs use significantly different sets of attributes.
- Some attributes are manufacturer-specific.
- 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 for “S.M.A.R.T.” and the attribute name.
- SMART Data is not terribly difficult to read and understand. More SMART info on the next page, illustrating a typical output for a SATA Hard Drive.
- If you have a question, ask for help deciphering the data.

# 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 read this before you begin 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 defines the meaning of what you are examining.
- VALUE is a Normalized value on the performance of this attribute.
- WORST is the worst VALUE observed over the life of the drive.
- THRESH is the lowest acceptable limit for VALUE and WORST. If VALUE or WORST for any attribute are below THRESH, the drive is considered failed. If THRESH is 0, the attribute is not considered life-critical (e.g. Power On Hours Count).
- RAW\_VALUE (*raw*) 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. The content of the RAW\_VALUE is (in general) vendor-specific.

- 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. If VALUE=20, I personally would replace immediately. NEVER WAIT UNTIL THE LAST MINUTE!

- 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. Dang, did I say something like this before?

```
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    00  Old_age Always        -        324
  5 Reallocated_Sector_Ct   0x0033   100    100    05  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    00  Old_age Always        -       55428
 10 Spin_Retry_Count        0x0013   100    100   060  Pre-fail Always        -         0
 12 Power_Cycle_Count       0x0032   100    100    00  Old_age Always        -        134
192 Power-Off_Retract_Count 0x0032   097    097    00  Old_age Always        -       4156
193 Load_Cycle_Count       0x0012   097    097    00  Old_age Always        -       4156
194 Temperature_Celsius     0x0002   171    171    00  Old_age Always        -        35 (Min/Max 19/45)
196 Reallocated_Event_Count 0x0032   100    100    00  Old_age Always        -         0
197 Current_Pending_Sector  0x0022   100    100    00  Old_age Always        -         0
198 Offline_Uncorrectable   0x0008   100    100    00  Old_age Offline       -         0
199 UDMA_CRC_Error_Count    0x000a   200    200    00  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): 0x0000000000000044
```

```
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 Cksum 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.