Why HDDFA ?

Hard Disk Failure Analysis

By Ron Dennison, CTO, HDDFA

Why HDDFA Hard Disk Failure Analysis ?

Poor Quality = Poor $ales

- BUT Only Tier 1 OEMs get factory FA
- Must understand failure root cause to improve system quality
- **HDDFA** provides root cause FA (**RCFA**)
  ➔ BETTER System QUALITY

Better Quality = Better $ales

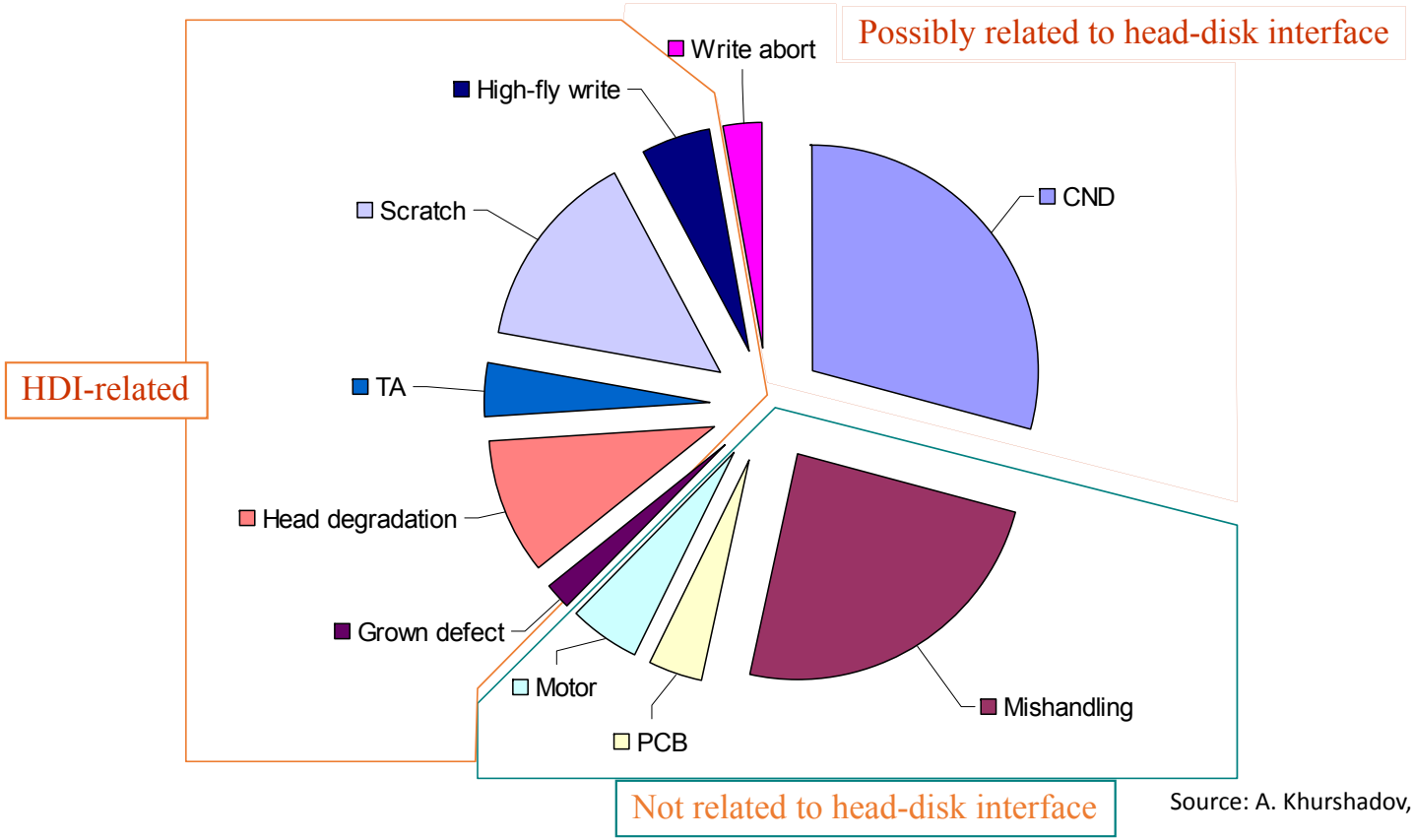
HDDFA Hard Disk Failure Analysis

Services

- **Root Cause FA coupled with**
- **Design Improvement Services**
  - **Selection (The RIGHT HDD/SSD)**
  - **Thermal Design (Hottest drive <45C)**
  - **Vibration/Shock Design (RV<12.5 rad/s^2)**
  - **Redundancy (Best RAID/Erasure Code, Logical to Physical Shelf/System, FRU)**

Why Do Drives Fail?

A generic HDD Failure Mode Pareto

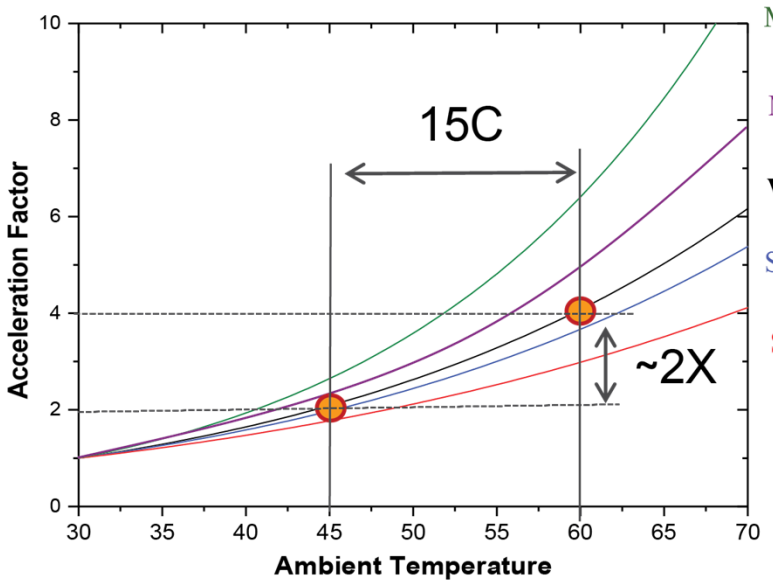


Source: A. Khurshadov, Samsung

While the “generic Pareto” remains the same, the specific distribution of failures is a strong function of the operating conditions

Why Do Drives Fail?

- **Wrong Environmental Specifications**
  - **Temperature**
  - Humidity
  - Altitude
  - Shock/Vibration
- Wrong Workload Specifications
  - Duty Cycle
  - Workload
  - Combinations



Maxtor:
Ea = 51.9 kJ mole^{-1}

Microsoft:
Ea = 44.4 kJ mole^{-1}

WD:
Ea = 39.3 kJ mole^{-1}

Seagate:
Ea = 36.4 kJ mole^{-1}

Samsung:
Ea = 30.6 kJ mole^{-1}

Source: WD

- **HDD reliability decreases with increasing temperature.**
- **Temperature is a major factor impacting reliability**

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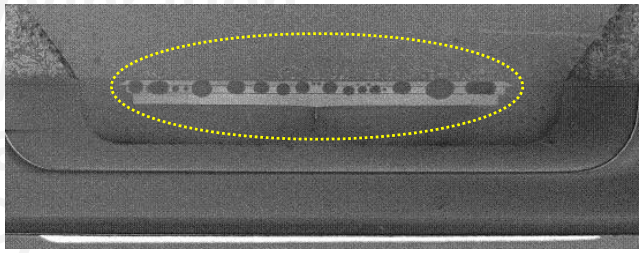
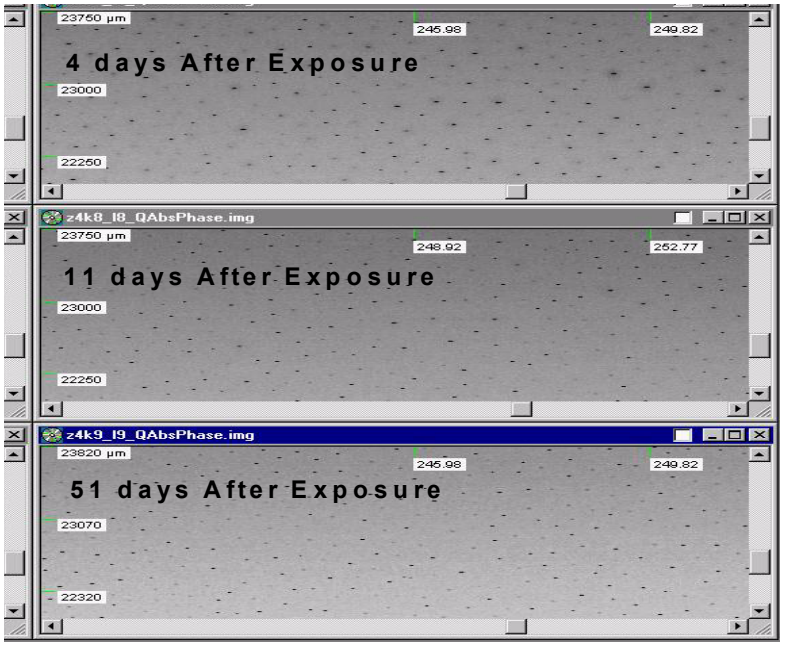
Moisture/Lube deposition on Slider



Courtesy: G.Tyndall (Samsung)

Moisture/Lube deposition on Disk



Courtesy: G.Tyndall (Samsung)

Humidity impacts PCB and penetrates inside the drive and can be a major cause of failure in both PC and CE environments

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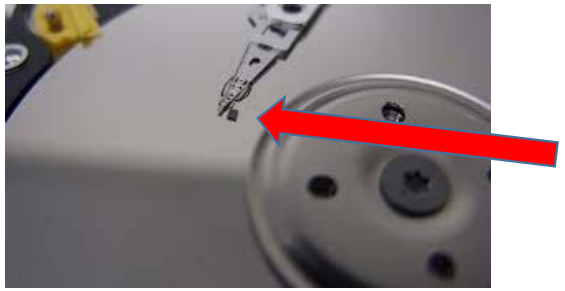
Corrosion

HDA Connector Corrosion

Stiction



Head Stuck to Disk

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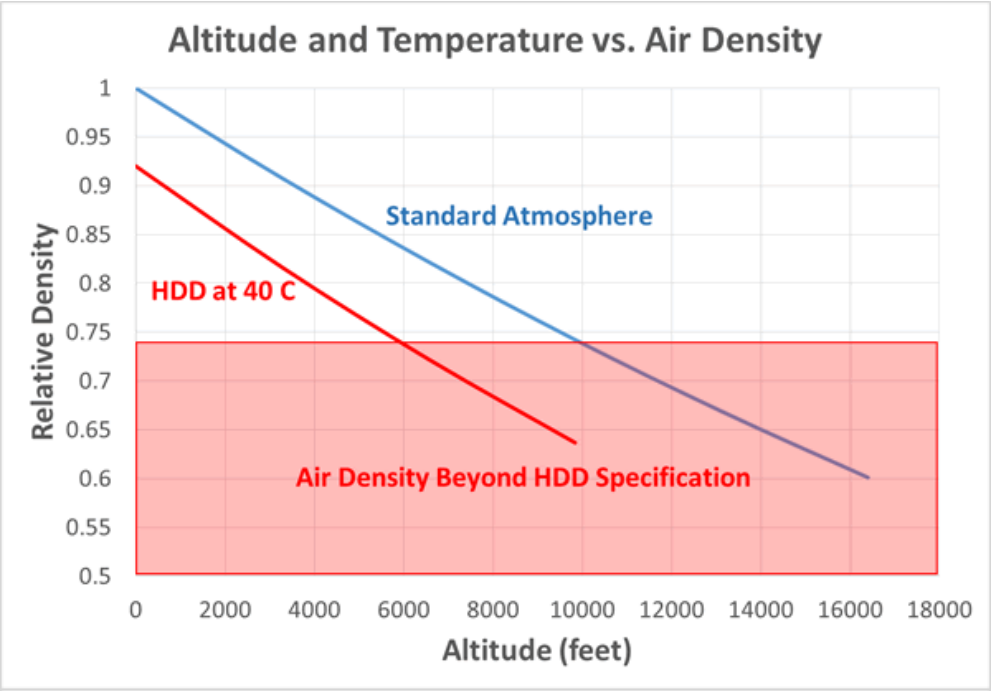

- All HDDs Limited to 10,000 ft or 3,000 m
- **BUT** Higher Altitude = Lower Air Density = Lower Head Flying Height
- Lower Flying Height = Higher Incidence of Head-Disk-Interference = Higher Annualized Failure Rate (AFR)

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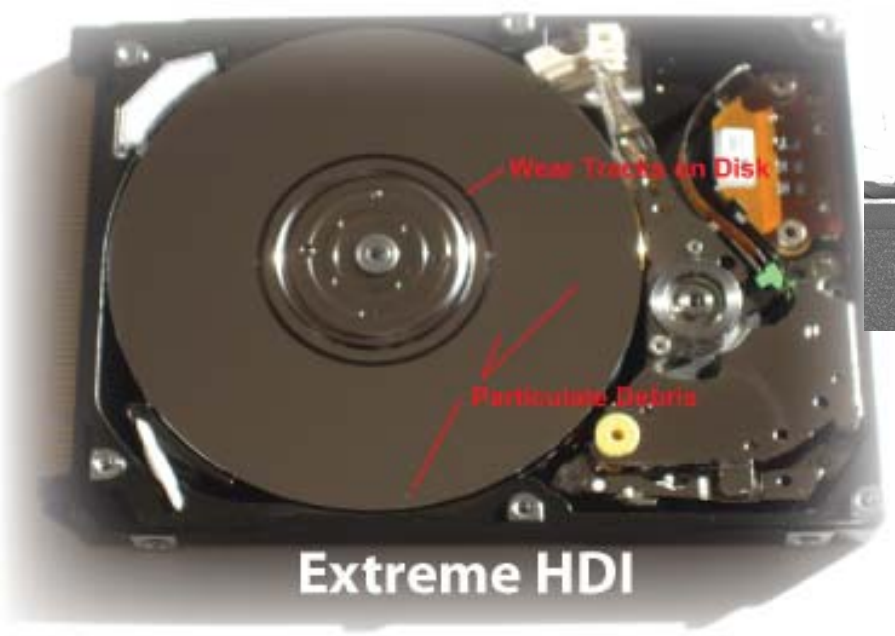
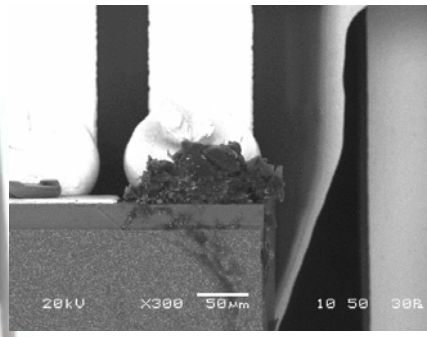
- #1 Cause of Field Failures
- Shock/Vibe ➔ HDI ➔ Failure





Debris on Trailing Edge of Head Slider

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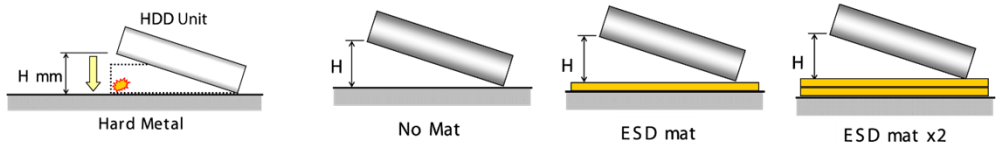

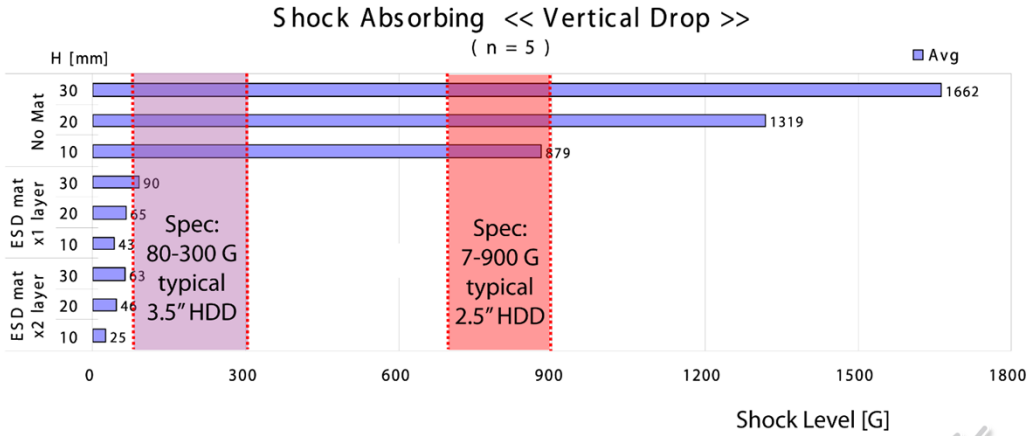

Source: Hitachi HDD Manufacturing Engineering, Fujisawa

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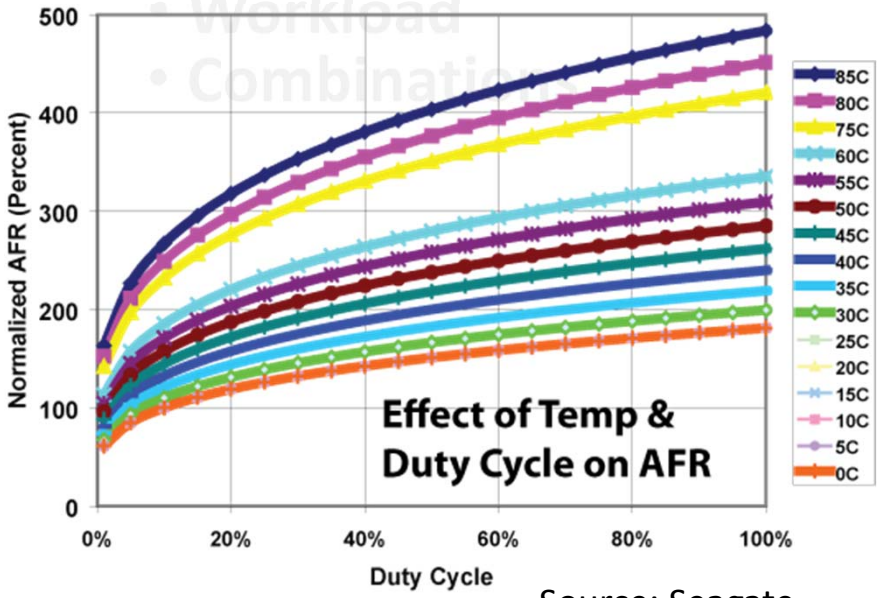
  - **Duty Cycle**



Source: Seagate

- Consumer HDDs rated for 8/5 operation or 2,000 hours/year.
- Consumer HDD AFRs calculated on 2k hours/year.
- Enterprise HDDs rated for 24/7 operation or 8,760 hours/year.
- Enterprise HDD AFRs calculated on 8,760 hours/year.
- **➔ 4X AFR Delta Enterprise/Client**

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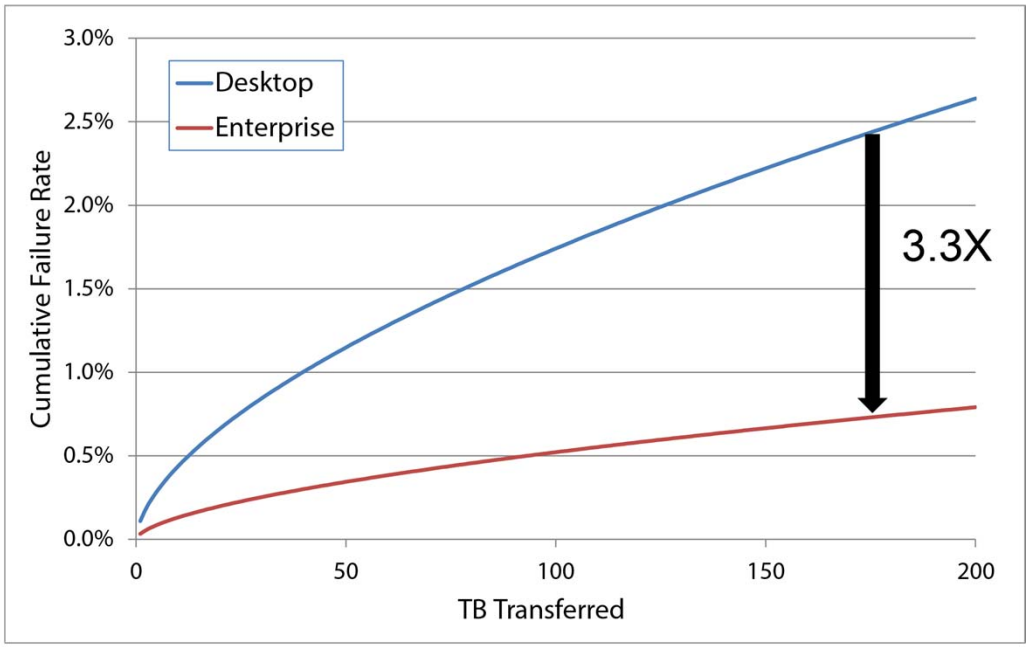

Source: WD

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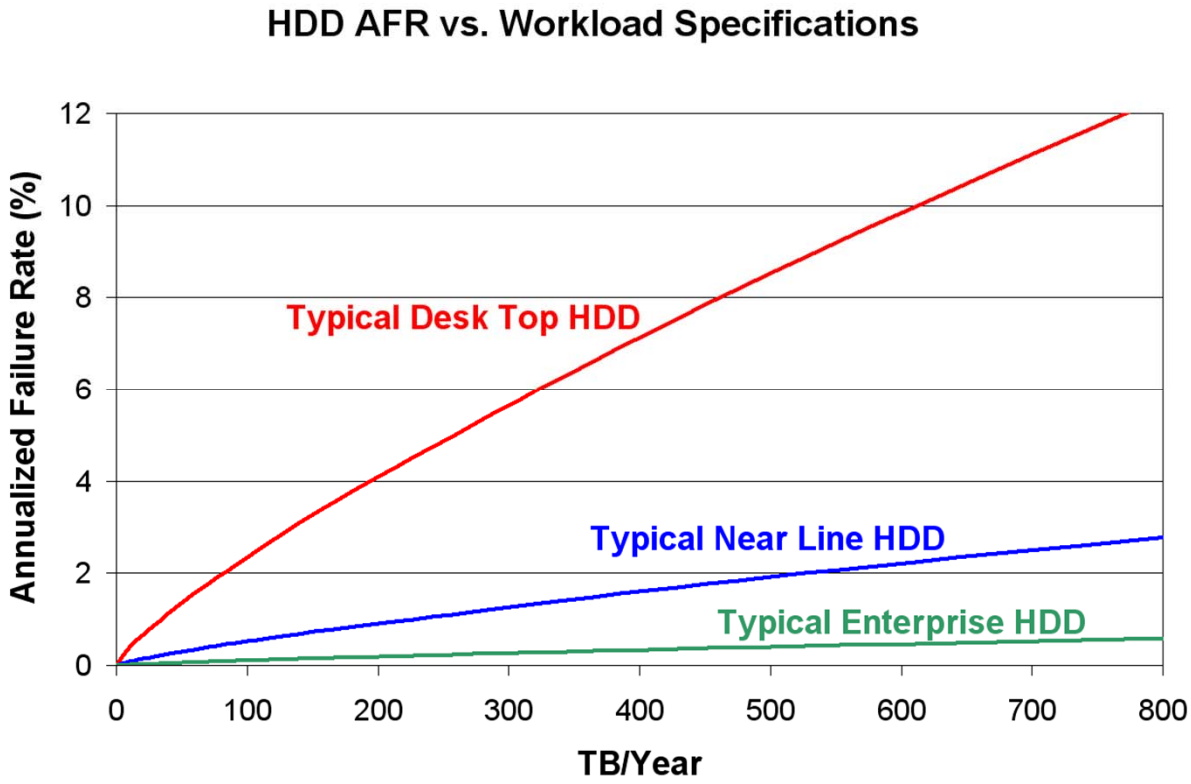

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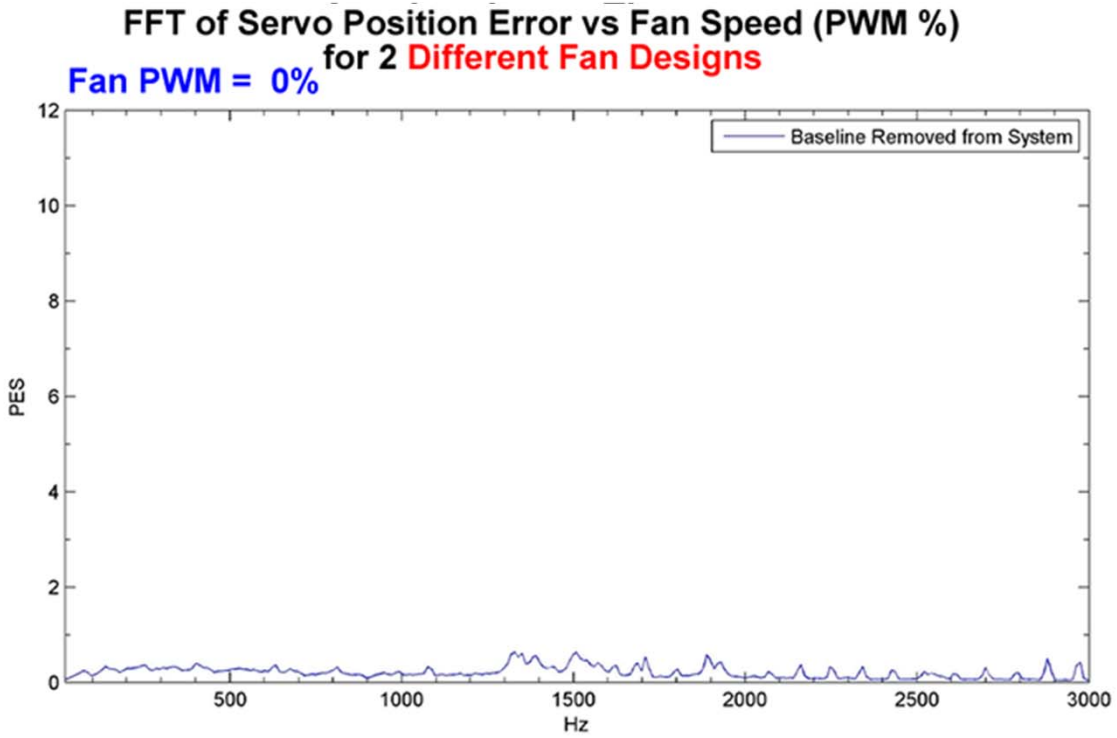

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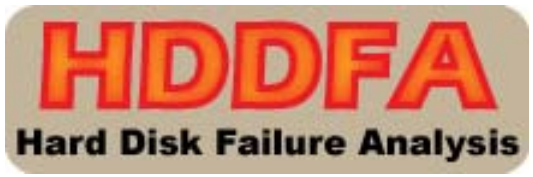
Annualized Failure Rates

HDD AFR 1-2% Normal

HDD AFR > 3% Need



Typical Early HDI Failure: "The Click of Death"

- Head/Media Damage Prevents Reading Servo Information
- Drive Loads Head, Makes Several Attempts to Find Servo Data, Parks Head
- Drive Unable to Complete POST

HDI Due to Ramp Damage/Wear

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