Through the Years: How Weight Has Impacted the Army's Wheeled Vehicle Reliability

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Agenda

- Data Set
- Study Assumptions
- Analysis
- Lessons Learned
- Path Forward

Data Set

- Reliability data taken from over **250,000 miles** of vehicle RAM testing from **10 years of testing**
  - Twelve (12) vehicles included in the study
    - Vehicle mileage ranged from 9,000 to 20,000 miles per vehicle
    - Vehicle weight increases ranged from 2,400 to 10,000 pounds
    - Weight increases due to additional armor integrated on platform
  - Reliability testing conducted at Aberdeen Proving Ground (APG) and Yuma Proving Ground (YPG)
- All vehicle testing conducted to support fielding of up-armored configuration of the vehicles

Presentation will include analysis conducted on two (2) vehicles

Study Assumptions

- Focus on vehicle subsystems that are assumed to be impacted the most by additional weight
  - Suspension
  - Driveline
  - Brakes
  - Steering
  - Wheel Assembly
  - Mission Equipment Package (MEP)
  - Cab
- All levels of reliability failure severities will be included in the analysis
- Disregard failures due to maintenance personnel, TMs, and operator, if appropriate
- If a major fix was incorporated into the up-weighted vehicle, disregard the associated failures on the baseline vehicle, if appropriate

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Physical Characteristics: Vehicle – 1 (V-1)

Increase of 10,000 lbs

- Additional weight, due to crew survivability and increased vehicle capabilities, has been added to support operations in OIF and OEF. Currently there are over 20 kits integrated on V-1, each with an associated weight burden
- Main weight related failures were observed on ALL major driveline and suspension subsystems and components

Vehicle	GVW (lbs)	RAM Test Miles
Baseline V-1	40,850	20,539
Up-weighted V-1	51,500	9,030

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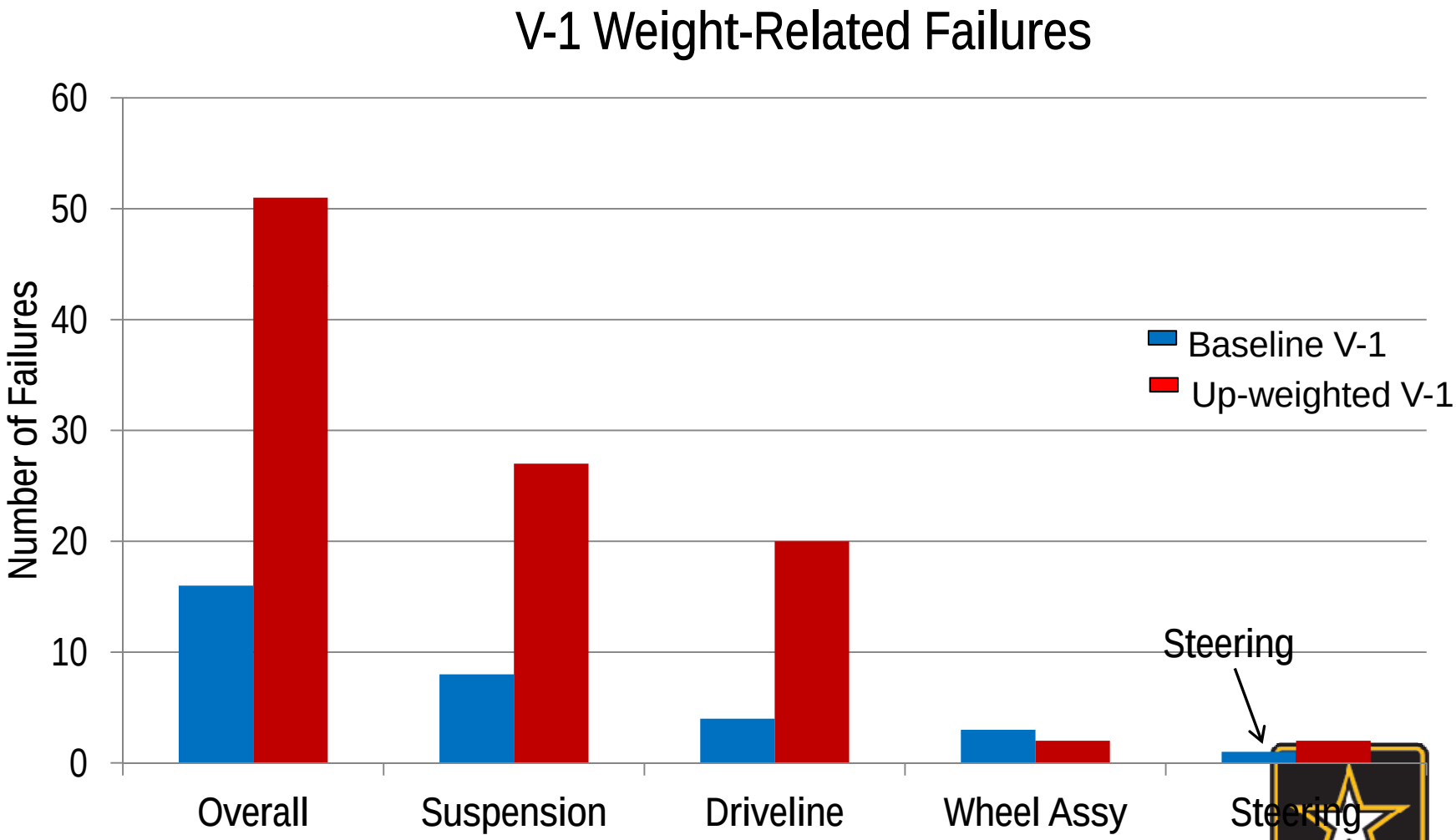
V-1 Failure Comparison



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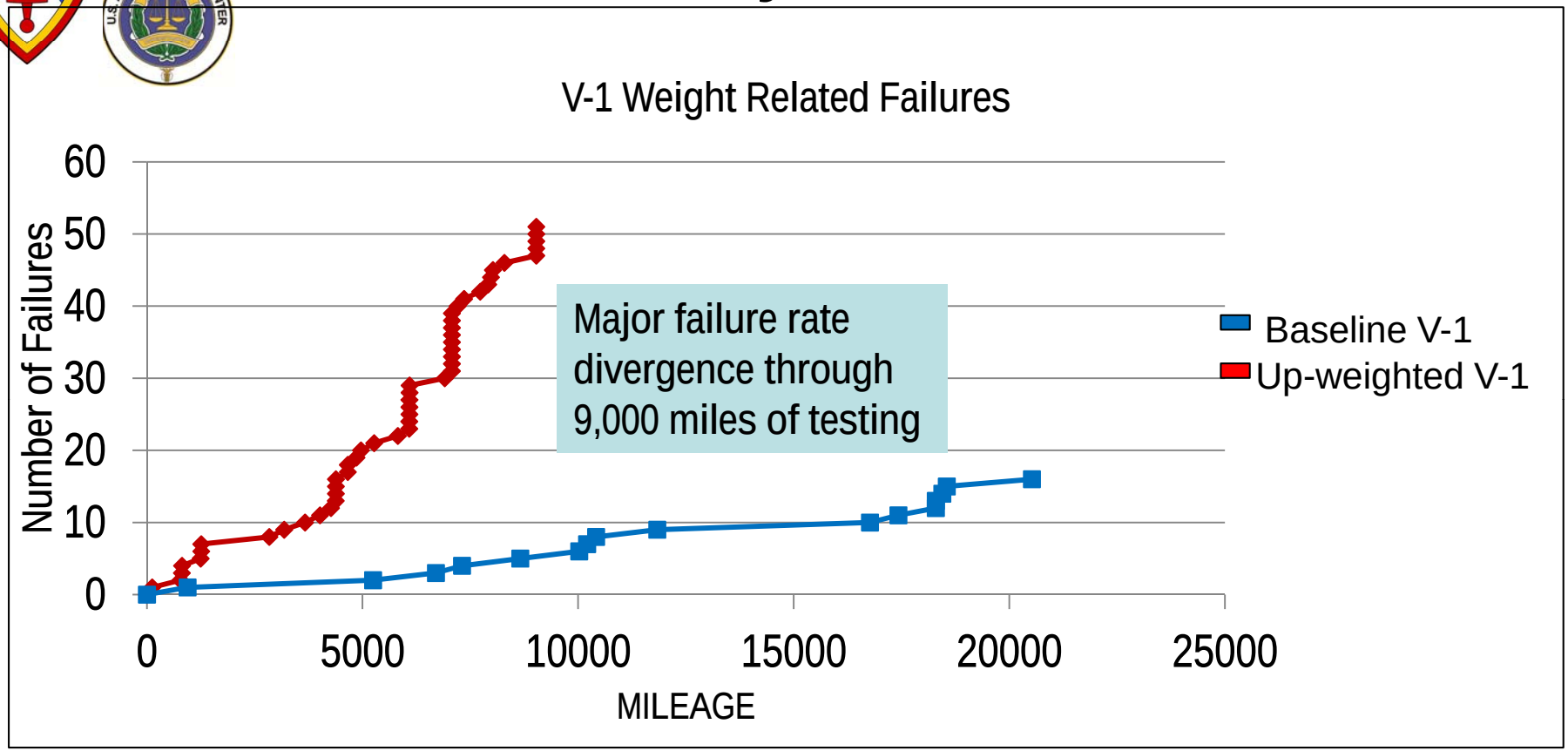
Analysis – V-1



- Driveline and suspension failures primary drivers of delta
- Major divergence of failure rates starting very early in test

Up-weighted V-1 has over
7x the **Total failure rate** of Baseline V-1

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Physical Characteristics: Vehicle – 2 (V-2)

Increase of 5,000 lbs

- Weight Modification: Modular opaque armor and transparent armor components added to cab for increased survivability
- Up-weighted V-2 experienced a higher failure rate on the following subsystems:
  - Cab/Body (broken cab latches)
  - Cab lifting/leveling mechanism (cylinder leaks, bushing)
  - Doors (cylinder leaks, frame bent)

Vehicle	GVW (lbs)	Test Miles
Baseline V-2	34,540	20,000
Up-weighted V-2	38,200	20,000

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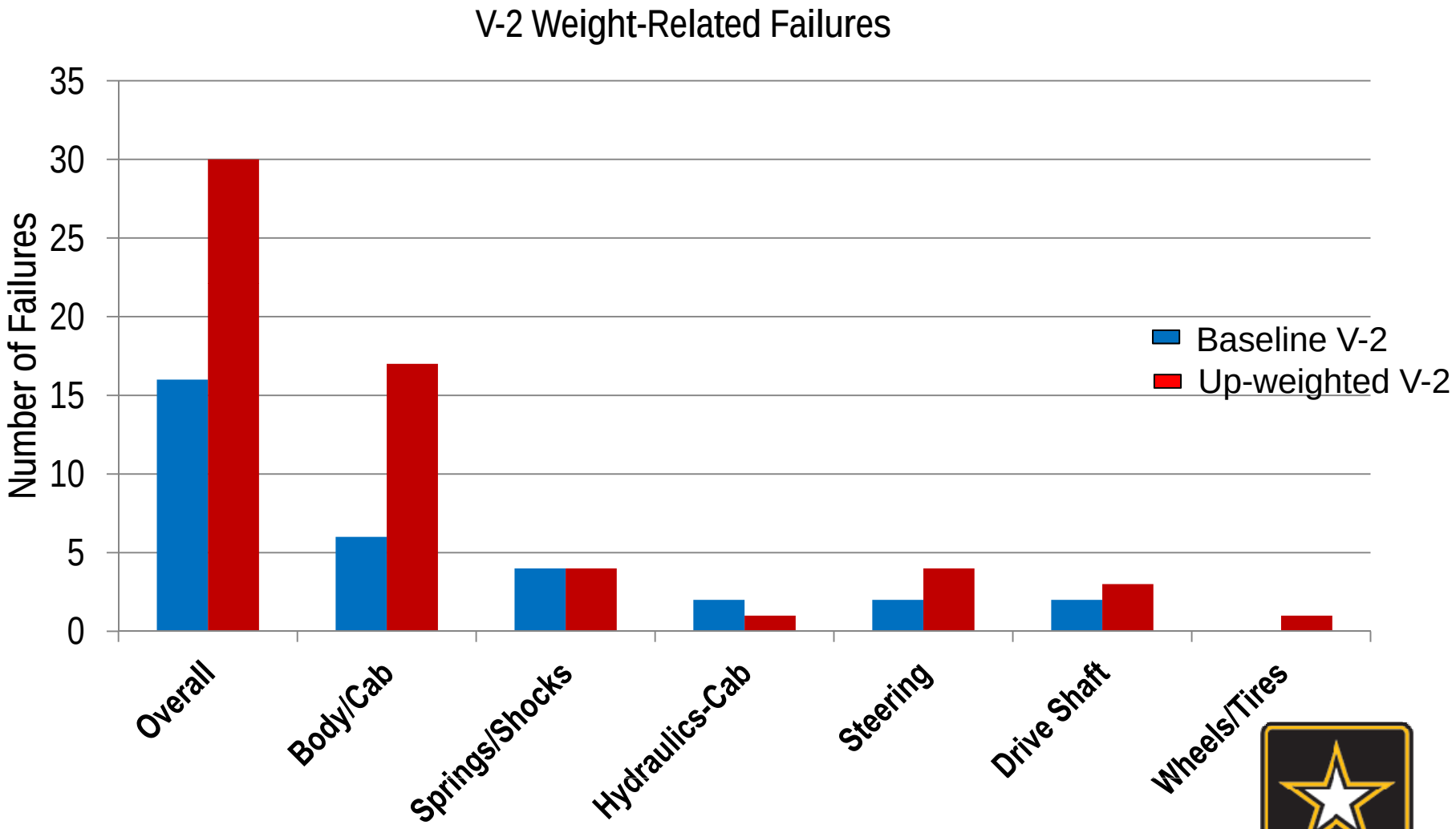
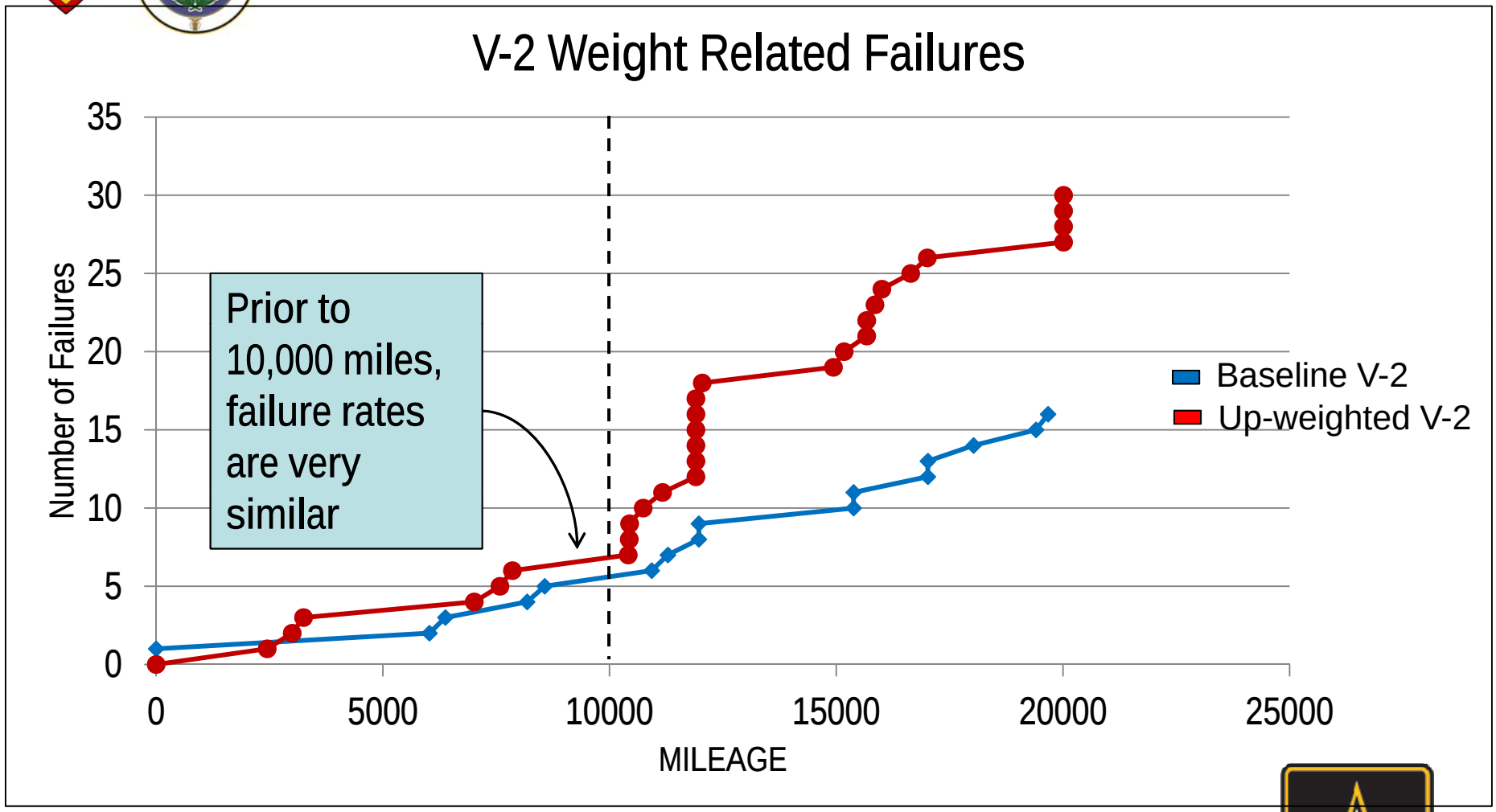
V-2 Failure Comparison



Analysis – V-2



V-2 failure rate is **2x** that of A Cab vehicle

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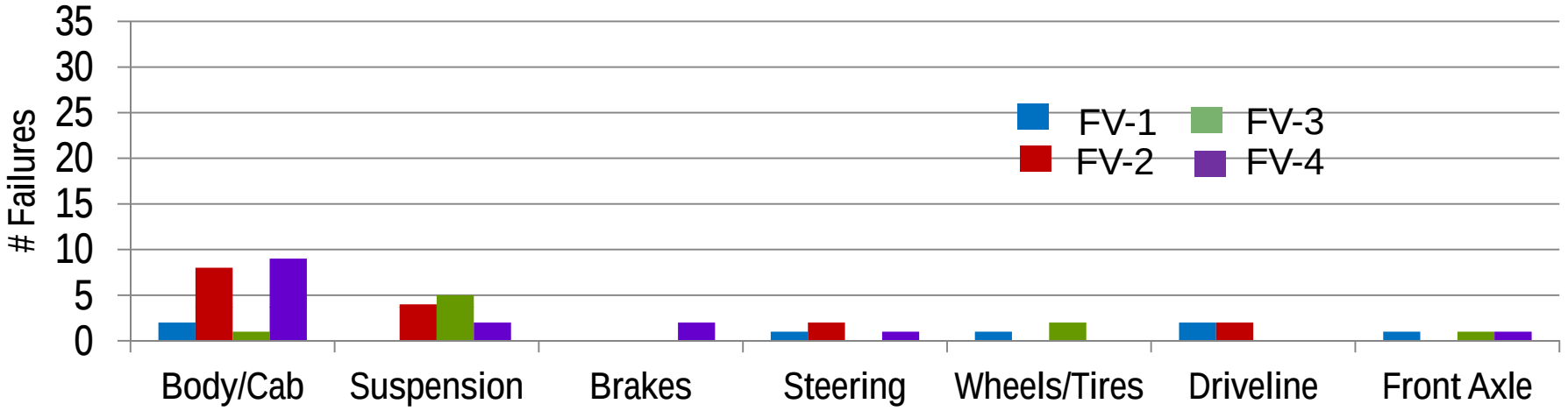
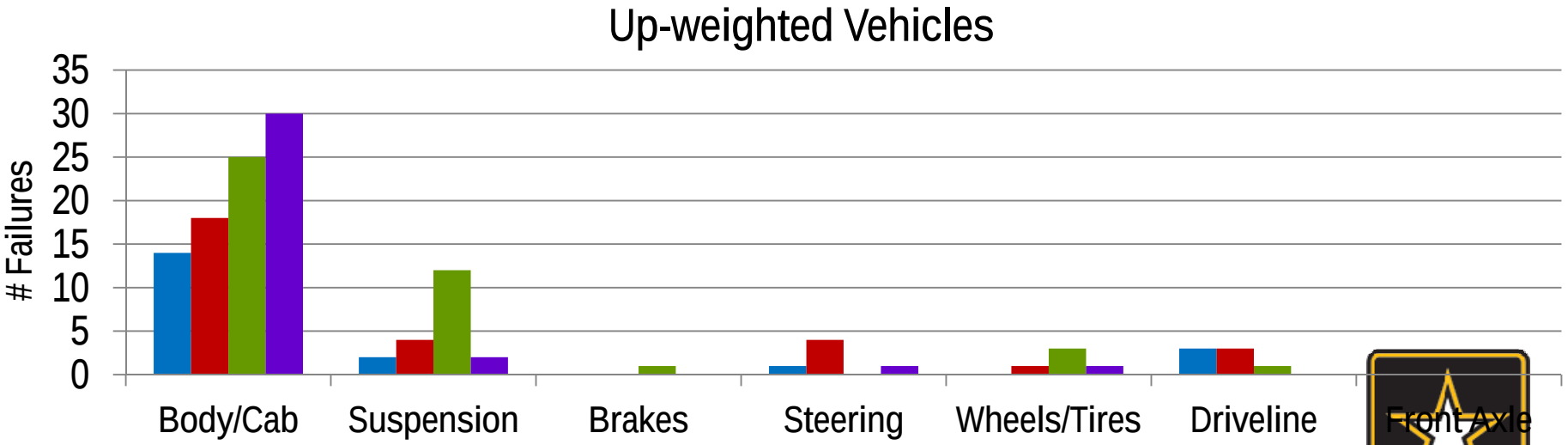
Family of Vehicles (FV) Comparison





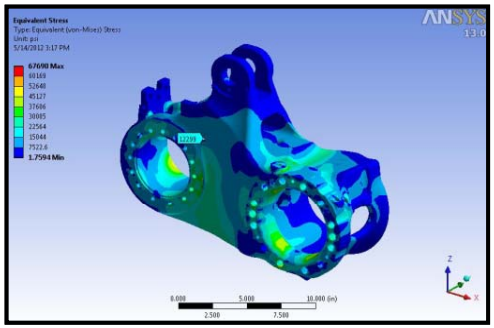
Lessons Learned

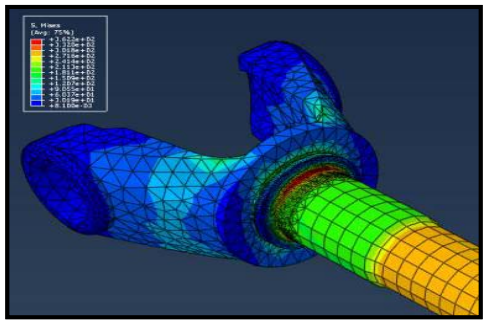
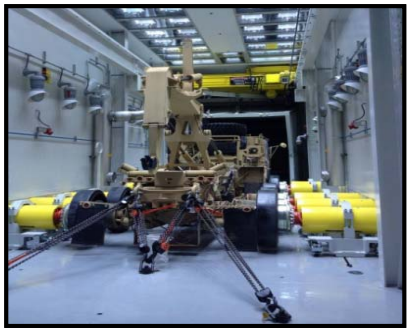
- Stresses are not well defined by vendor prior to up-weighting vehicles
  - Currently vendors are working independently, leading to a misunderstanding of how vehicles will be tested and evaluated
  - Vehicle instrumentation and M&S and can assist IPT to better understand and communicate stresses and implement corrective actions prior to testing
- RAM Data Collection and Maintenance Procedures
  - Increase vehicle inspections:
    - Result will be better understanding of where failures are occurring on and off courses (e.g. tire failures observed in maintenance)
    - Inspecting vehicle for failures more frequently may lead to correlating failures to terrain/course conditions (e.g. driveline failures on particular courses

Early M&S and instrumentation may lead to a better understanding of reliability impacts to weight related failure modes

Path Forward

- Develop O&S costs associated with increased failure rates
- Early implementation of M&S (PoF, FEA, vehicle simulators) can assist early reliability engineering risk assessments prior to starting RAM testing
- Determining a valid M&S approach early can potentially reduce required mileage based on the up-weighted vehicle study
  - Evaluate historical baseline and up-weighted vehicle failure rate similarities and differences on previously tested vehicles

Continue to pursue M&S capabilities to develop effective RAM test design and O&S impacts

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Summary

- Vehicle weight will continue to fluctuate
  - Vehicles will continue to have requirements leveraged on them to increase survivability, improve communications, and/or lethality = WEIGHT!
  - Implementing additional weight smartly through understanding potential reliability impacts prior to integration will decrease reliability impacts
  - Better understanding needed of increased Operations and Support (O&S) costs from reliability impacts (increased part replacements, maintenance, etc.)
- Improve early reliability engineering risk assessments
  - Develop approach using M&S to understand reliability risk areas

Effective Reliability T&E program vital to capturing weight impacts