NPS-LM-25-263

ACQUISITION RESEARCH PROGRAM SPONSORED REPORT SERIES

Adapting and Improving the Amphibious Combat Vehicle Operational Readiness

December 2024

Capt Sean Fitzpatrick, USMC

Capt Dominick C. DiSerio, USMC

Thesis Advisors: Dr. Robert F. Mortlock, Professor
Raymond D. Jones, Professor

Department of Defense Management

Naval Postgraduate School

The research presented in this report was supported by the Acquisition Research Program of the Department of Defense Management at the Naval Postgraduate School.

To request defense acquisition research, to become a research sponsor, or to print additional copies of reports, please contact the Acquisition Research Program (ARP) via email, arp@nps.edu or at 831-656-3793.

ABSTRACT

In 2018 the U.S. Marine Corps selected BAE Systems to manufacture the next generation of armored amphibious vehicles, named the Amphibious Combat Vehicle (ACV). The ACV was designed to support Marine Corps amphibious operations by protecting Marines as they transit from ship to shore under combat and non-combat environments. In November 2020 the first shipment of ACVs was reported to hit the Marine Corps Fleet. As the Marine Corps continues to transition the aging fleet of Assault Amphibian Vehicles to ACVs, fleet readiness on the new ACV is significantly lower than expected. The reduced readiness of the ACV limits the Marine Corps' ability to prepare for and respond to global conflict. The focus of this research is to examine why ACV readiness levels are low and suggest steps that could be taken at the unit, organization, and program management levels to improve the overall readiness of ACVs. The findings indicate consistent problems with major ACV subsystems, especially suspension, as well as compounding issues within the logistics chain and unit staffing. As new ACV variants approach production and deployment and more ACVs are fielded to the fleet, considerations should be made to potential changes in unit Tables of Organization and Equipment (TO&E), reevaluation of support contracts, additional test and evaluation (T&E) and conducting an independent readiness assessment.

THIS PAGE INTENTIONALLY LEFT BLANK

ABOUT THE AUTHORS

Captain Dominick "STAQ" DiSerio was born and raised in Stockton, CA and graduated from the US Naval Academy in 2015 with a degree in Weapons and Systems Engineering. He went on to attend flight school and earned his wings of gold in 2018. In 2019 he deployed with VMM-161 to Kuwait in support of Operation Inherent Resolve in Iraq and Syria. He deployed again in 2021 to Al-Udeid Air Base in Qatar as a Marine liaison to the Combined Air Operations Center and supported Operation Allies Refuge. Captain DiSerio was accepted to Naval Postgraduate School in November 2022 and volunteered as one of the first Marines to take the 816 curriculum, Defense Program Management. After graduation he will report to the Program Manager, Ground Based Air Defense Systems, Marine Corps Systems Command, in Quantico, VA as a Defense Systems Acquisition Officer. Captain DiSerio has a boxer dog named Dio (after the heavy metal singer) who is a good boy and a loyal companion.

Captain Sean Fitzpatrick was born and raised in Philadelphia, PA. He attended Pennsylvania State University, where he attained a Bachelor of Science in Mechanical Engineering in 2016. Captain Fitzpatrick subsequently commissioned in the Marine Corps in May 2016 through the PLC commissioning program. Following graduation from The Basic School, Captain Fitzpatrick was assigned to Marine Aircraft Group 31 as the Ground Supply. In August 2020, Captain Fitzpatrick was assigned to I MEF Support Battalion as the Battalion Supply Officer and additionally served as the I MEF Support Battalion Headquarters Company, Company Commander from March to July 2022. Captain Fitzpatrick reported to Naval Postgraduate School in June 2023 to study Systems Acquisition Management (Curriculum 816) and is expected to conduct his follow-on assignment at Marine Corps Systems Command upon graduation in December 2024.

THIS PAGE INTENTIONALLY LEFT BLANK

ACKNOWLEDGMENTS

We express sincere appreciation to those who supported these research efforts, especially our family, friends, colleagues and NPS professors. We would like to especially thank our advisors, Dr. Robert Mortlock and Raymond Jones, for their direction, support, and feedback throughout this research. We would additionally like to show gratitude to the Marines actively working with, supporting, sustaining, and improving the Amphibious Combat Vehicle, particularly CWO4 Roy Farner, CWO4 Jonathan Overs, and CWO4 Thomas Marshall.

THIS PAGE INTENTIONALLY LEFT BLANK

NPS-LM-25-263

ACQUISITION RESEARCH PROGRAM
SPONSORED REPORT SERIES

Adapting and Improving the Amphibious Combat Vehicle Operational Readiness

December 2024

Capt Sean Fitzpatrick, USMC
Capt Dominick C. DiSerio, USMC

Thesis Advisors: Dr. Robert F. Mortlock, Professor
Raymond D. Jones, Professor

Department of Defense Management

Naval Postgraduate School

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

I. INTRODUCTION ... 1
- A. PROBLEM ... 1
- B. SCOPE ... 2
- C. RESEARCH QUESTIONS ... 2
- D. CHAPTER SUMMARY ... 2

II. BACKGROUND ... 3
- A. AMPHIBIOUS OPERATIONS ... 3
- B. OVERVIEW OF THE AMPHIBIOUS COMBAT VEHICLE ... 4
- C. CURRENT ASSAULT AMPHIBIAN BATTALION MODEL ... 6
- D. PROGRAM HISTORY ... 8
- E. GOVERNMENT ACCOUNTABILITY OFFICE REPORTS ... 9
- F. CHAPTER SUMMARY ... 9

III. LITERATURE REVIEW ... 11
- A. RELIABILITY ... 11
- B. PROBLEM ANALOGUES IN THE V-22 PROGRAM ... 13
- C. CHAPTER SUMMARY ... 16

IV. METHODOLOGY ... 17
- A. SOURCES ... 17
- B. CHAPTER SUMMARY ... 19

V. ANALYSIS AND FINDINGS ... 21
- A. GCSS-MC SERVICE REQUESTS AND DEFINITIONS ... 21
  - 1. Operational Status ... 22
  - 2. Severity ... 22
  - 3. Problem Codes ... 23
  - 4. Limitations ... 23
- B. CORRELATION BETWEEN SEVERITY AND OPERATIONAL STATUS ... 23
- C. CLOSED SERVICE REQUESTS ... 27
  - 1. Severity and Problem Code Correlations ... 27
  - 2. Problem Code and Operational Status Correlations ... 34
  - 3. Additional Observations ... 37
- D. OPEN SERVICE REQUESTS ... 40
  - 1. Severity and Problem Code Correlations ... 41

2. Problem Code and Operational Status Correlations 45
3. Job Status Correlations 48
4. Additional Observations 54
E. ACV STAFFING 55
1. Headquarters and Service Company 55
2. Alpha Company 57
3. Bravo Company 58
4. Charlie Company 59
F. AAV STAFFING 60
1. Headquarters and Service Company 60
2. Alpha Company 62
3. Bravo Company 63
G. CAPABILITY DEVELOPMENT DOCUMENT 64
1. 5.1.1 Materiel Availability 64
2. 5.1.2 Operational Availability 64
3. 5.3.28 Maximum Time to Repair 65
4. 5.3.30 ACV Training 65
H. LIFE CYCLE SUSTAINMENT PLAN 65
I. CHAPTER SUMMARY 66

VI. SUMMARY, CONCLUSIONS, AND AREAS FOR FURTHER RESEARCH . 67
A. RESEARCH LIMITATIONS 67
B. SUMMARY OF FINDINGS 67
C. REVIEW OF RESEARCH QUESTIONS 68
D. SUGGESTIONS FOR FURTHER RESEARCH 70

APPENDIX A. GCSS-MC REPORT SAMPLE 71

APPENDIX B. GCSS-MC SERVICE REQUEST PROCESS MAP 73

VII. APPENDIX C. GCSS-MC PRIORITY DESIGNATOR (SEVERITY) CODES 75

APPENDIX D. GCSS-MC MAINTENANCE PROBLEM CODES 77

APPENDIX E. RELEVANT GCSS-MC JOB STATUS CODES 81

LIST OF REFERENCES 85

LIST OF FIGURES

Figure 1. Amphibious Combat Vehicle. Source: BAE Systems (2018). 5

Figure 2. AAV (left) and ACV (right). Source: MCTSSA (n.d.).............................. 6

Figure 3. AA Company Organizational Chart. Source: U.S. Marine Corps (2023)... 7

Figure 4. Bathtub Failure Rate Curve. Source: Blanchard (2004) 12

Figure 5. MV-22B Osprey. Source: Busby (2024) 13

Figure 6. CH-46E Sea Knight. Source: Fandom, Inc. (n.d.) 14

Figure 7. Total Number of Closed SRs, Operational–Minor by Severity Category 24

Figure 8. Total Number of Closed SRs, Operational–Degraded by Severity Category 25

Figure 9. Total Number of Closed SRs, Deadlined by Severity Category............... 25

Figure 10. Total Number of Open SRs, Operational–Minor by Severity Category 26

Figure 11. Total Number of Open SRs, Deadlined and Operational–Degraded by Severity Category.. 27

Figure 12. Total Number of Closed Service Requests by Severity Category 28

Figure 13. Pareto Chart of ACV Subsystem Closed SRs Categorized "C-Routine" 31

Figure 14. Pareto Chart of ACV Subsystem Closed SRs Categorized "A-Critical" or "B-Urgent".. 34

Figure 15. Histogram of Aggregated Closed Service Requests Across Individual ACV System Serials 38

Figure 16. Histogram of Closed SR Frequency of Total Days Open Before Closeout 40

Figure 17. Number of 3d AABn Open SRs by Severity Category............................ 41

Figure 18. Pareto Chart of ACV Subsystem Closed SRs Categorized "B-Urgent"... 43

Figure 19. Pareto Chart of ACV Subsystem Closed SRs Categorized "A-Critical"... 44

Figure 20. Pareto Chart of ACV Subsystems Open SRs Maintaining Operational Status "Deadlined" ... 48

Figure 21. Pareto Chart of 3d AABn Open SRs by Job Status ... 50

LIST OF TABLES

Table 1. 3d AABn Closed SRs by Operational Status and Severity 24

Table 2. Fleetwide Open SRs by Operational Status and Severity 26

Table 3. Number of Closed Service Requests by Severity Category 28

Table 4. Closed SRs Categorized "C-Routine" by Problem Code Occurrence, All 29

Table 5. Closed SRs Categorized "C-Routine" by Problem Code Occurrence, Subsystems 30

Table 6. Closed SRs Categorized "A-Critical" or "B-Urgent" by Problem Code Occurrence 33

Table 7. Closed SRs with Operational Status "Operational – Minor" by Problem Code Occurrence, All 35

Table 8. Closed SRs with Operational Status "Operational–Minor" by Problem Code Occurrence, Subsystems 36

Table 9. Closed SRs with Operational Status "Deadlined" or "Operational–Degraded" by Problem Code Occurrence 37

Table 10. Closed SR Days Open Descriptive Statistics 39

Table 11. Number of 3d AABn Open SRs by Severity Category 41

Table 12. 3d AABn Open SRs Categorized "C-Routine" by Problem Code Occurrence 42

Table 13. 3d AABn Open SRs Categorized "B-Urgent" by Problem Code Occurrence 42

Table 14. 3d AABn Open SRs Categorized "A-Critical" by Problem Code Occurrence 44

Table 15. 3d AABn Open SRs with Operational Status "Operational– Minor" by Problem Code Occurrence 46

Table 16. 3d AABn Open SRs with Operational Status "Operational–Degraded" by Problem Code Occurrence 46

Table 17. 3d AABn Open SRs with Operational Status "Deadlined" by Problem Code Occurrence 47

Table 18. 3d AABn Open SRs by Job Status Occurrence 49

Table 19. 3d AABn Open SRs Maintaining Operational Status "Operational – Minor" by Job Status Occurrence 51

Table 20. 3d AABn Open SRs Maintaining Operational Status "Operational – Degraded" by Job Status Occurrence 51

Table 21. 3d AABn Open SRs Maintaining Operational Status "Deadlined" by Job Status Occurrence 52

Table 22. 3d AABn Open SRs Maintaining Operational Status "Operational – Degraded" or "Deadlined" with "Approved" Job Status by Problem Code Occurrence 53

Table 23. 3d AABn Open SRs Maintaining Operational Status "Operational – Degraded" or "Deadlined" with "SHT PART" Job Status by Problem Code Occurrence 54

Table 24. Maintenance Platoon H&S CO 3D AA BN 1ST MARDIV 57

Table 25. Alpha CO 3D AA BN 1ST MARDIV 58

Table 26. Maintenance Section Alpha CO 3D AA BN 1ST MARDIV 58

Table 27. Maintenance Repair Teams Alpha CO 3D AA BN 1ST MARDIV 58

Table 28. Maintainer-to-Vehicle Ratio 58

Table 29. Bravo CO 3D AA BN 1ST MARDIV 59

Table 30. Maintenance Section Alpha CO 3D AA BN 1ST MARDIV 59

Table 31. Maintainer-to-Vehicle Ratio 59

Table 32. Charlie CO 3D AA BN 1ST MARDIV 60

Table 33. Maintenance Section Alpha CO 3D AA BN 1ST MARDIV 60

Table 34. Maintainer-to-Vehicle Ratio 60

Table 35. Maintenance Platoon H&S CO 2D AA BN 2D MARDIV 61

Table 36. Maintenance Section Alpha CO 2D AA BN 2D MARDIV 63

Table 37. Maintenance Section Bravo CO 2D AA BN 2D MARDIV 63

LIST OF ACRONYMS AND ABBREVIATIONS

AA	Assault Amphibian
AAA	Advanced Amphibious Assault
AABn	Assault Amphibian Battalion
AAS	Assault Amphibian School
AAV	Assault Amphibious Vehicle
ACAT	Acquisition Category
ACV	Amphibious Combat Vehicle
ACV-30	ACV 30mm Cannon
ACV-C	ACV Command and Control
ACV-P	ACV Personnel Carrier
ACV-R	ACV Recovery
APA	Additional Performance Attribute
ARMT	Armament
AWTG	Awaiting
CBB	Cracked, Broken, or Bent
CDD	Capability Development Document
CM	Corrective Maintenance
COMP	Component
CONUS	Continental United States
COTO	Components Out of Tolerance
COTS	Commercial-Off-The-Shelf
CTR	Contractor
CWO	Chief Warrant Officer
DAD1	Data/Digital Systems
DLA	Defense Logistics Agency
DoD	Department of Defense
DOT&E	Director, Operational Test and Evaluation
DOTmLPF-P	Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities, and Policy
EFV	Expeditionary Fighting Vehicle
FAD	Force Activity Designator

FCON	Fire Control Systems
FMECA	Failure Modes, Effects, and Criticality Analysis
FoV	Family of Vehicles
FY	Fiscal Year
GAO	Government Accountability Office
GCE	Ground Combat Element
GCSS-MC	Global Combat Support System-Marine Corps
HMM	Marine Medium Helicopter Squadron
HYDR	Hydraulic
INOP	Inoperative
IOT&E	Initial Operational Test and Evaluation
JLTV	Joint Light Tactical Vehicle
JROC	Joint Requirements Oversight Committee
KPP	Key Performance Parameter
KSA	Key System Attribute
LCSP	Life Cycle Sustainment Plan
LOGCOM	Logistics Command
LRIP	Low-Rate Initial Production
MAGTF	Marine Air-Ground Task Force
MARCORSYSCOM	Marine Corps Systems Command
MARFORRES	Marine Forces Reserve
MCOTEA	Marine Corps Operational Test and Evaluation Activity
MCTSSA	Marine Corps Tactical Systems Support Activity
MODAP	Modification
MRL	Manufacturing Readiness Level
MRV	Mission Role Variants
NALCOMIS	Naval Aviation Logistics Command Management Information Systems
NDAA	National Defense Authorization Act
NDI	Non-Developmental Item
NMAJ	No Major Defect
NMESIS	Navy-Marine Expeditionary Ship Interdiction System
NPS	Naval Postgraduate School

OA	Operational Assessment
OCONUS	Outside the Continental United States
OEM	Original Equipment Manufacturer
OMF	Organizational Maintenance Facility
OPNET	Operators New Equipment Training
PM	Preventative Maintenance
PMCS	Preventative Maintenance Checks and Services
PWRT	Powertrain
RGT	Reliability Growth Test
RQT	Reliability Qualification Testing
SAIC	Science Applications International Corporation
SEAL	Seals and Gaskets
SHT	Short
SL-3	Stock List-3
SPRG	Springs, Shocks and Stabilizer Components
SR	Service Request
SUSP	Suspension
TEDD	Test Equipment/Display Devices
TEEP	Training, Exercise, and Employment Plan
TFSMS	Total Force Structure Management System
TO&E	Tables of Organization and Equipment
UDP	Unit Deployment Program
VMM	Marine Medium Tiltrotor Squadron
WPNS	Weapons/Small Arms/Crew Served

THIS PAGE INTENTIONALLY LEFT BLANK

I. INTRODUCTION

The Marine Corps is in the process of replacing the Assault Amphibian Vehicle (AAV) with the Amphibious Combat Vehicle (ACV) to conduct amphibious operations. The Program Manager Advanced Amphibious Assault has reported fleet readiness for the ACV as critically below standards–sitting at 50% with the main operational unit, and the Third Assault Amphibian Battalion (3d AABn), being around 30% (K. Andrews, Program Manager Advanced Amphibious Assault (AAA), email to author, October 17, 2023). The current Assault Amphibian (AA) maintenance model is based on the legacy AAV platform and organizational structure, except for increasing the number of vehicles assigned to each unit (18-vehicle vice 12-vehicle AAV companies). The ACV differs from the AAV in significant ways that severely restrict field maintenance capability and increase mean time to repair. While the number of available mechanics for each company has increased from 25 to 36, battalion maintenance staff are interested in adding 10 to 15 more personnel to decrease the backed-up workload (R. Farner, Battalion Maintenance Officer, 2d AABn, interview with author, November 3, 2023).

A. PROBLEM

In March 2023 General Berger testified before the Senate Appropriations Committee that "the introduction of the ACV has the potential to greatly enhance our littoral mobility and expeditionary reach" (Berger, 2023). Unfortunately, the Marine Corps cannot leverage these new capabilities if vehicles are not operationally ready. The legacy AA maintenance model does not meet the logistical demands and requirements of the new ACV. Shortfalls in supply, manpower, and expertise are significant factors to current material readiness levels (R. Farner, Battalion Maintenance Officer, 2d AABn, interview with author, November 3, 2023). This research aims to narrow down these factors via regression and root cause analysis. Barriers to success are identified in both the short and long term to improve material readiness and contribute to higher system availability and reliability.

This research contributes lessons learned to the fielding of future military vehicles. The common practice of conducting a one-for-one swap of a new system that fulfills an existing mission set has historically driven middle to late-in-life alterations of unit structure and supply chain requirements. The Marine Corps is concurrently fielding new systems in existing units such as the Joint Light Tactical Vehicle (JLTV), Navy-Marine Expeditionary Ship Interdiction System (NMESIS), and the F-35 Lightning II. Lessons learned from the initial operational fielding of the ACV could positively affect these programs and others like them.

B. SCOPE

This research provides insight into potential actions at the unit, organization, and program management levels that may improve the overall readiness of Assault Amphibious Battalions currently fielding the ACV as well as inform units undergoing transition to the ACV from the AAV system. Additionally, the research offers perspective for suitable change recommendations for training and education to bolster subject matter expertise that could mitigate the initial challenges of fielding the ACV to transitioning units.

C. RESEARCH QUESTIONS

1. What steps could be taken at the unit, organization, and program management levels to improve the overall readiness of Assault Amphibious Battalions currently equipped with the ACV as well units undergoing transition to the ACV from the AAV?
2. What can be learned from the maintenance model of similar systems?
3. What implications will any potential findings have for the introduction of new replacement systems?

D. CHAPTER SUMMARY

This research focuses on identifying, analyzing, and addressing the factors negatively affecting the ACV fleet readiness. Key sources of data include maintenance service requests, Tables of Organization and Equipment, Capability Development Document, and the ACV Family of Vehicles Life Cycle Sustainment Plan Version 3.0. The next chapter will provide a background of amphibious operations and an overview of the AABn Model.

II. BACKGROUND

In this section, the contextual background of amphibious operations requirements in the Marine Corps, an overview of the ACV, and the current AABn Model is discussed. Additionally, the history of the ACV program and relevant reports from the Government Accountability Office (GAO) are introduced.

A. AMPHIBIOUS OPERATIONS

U.S. Code, Title 10-Armed Forces outlines the Marine Corps shall "be organized, trained, and equipped to provide fleet Marine forces of combined arms, together with supporting air components, for service with the fleet in the seizure or defense of advanced naval bases and for the conduct of such land operations as may be essential to the prosecution of a naval campaign" (U.S. Code, Title 10, § 5063, 2018). This is the baseline legal precedence that guides the Marine Corps regarding their role in the United States Armed Forces and has been one of the fundamental arguments for the Marine Corps to operate and sustain itself as a separate military branch under the Department of the Navy.

Doctrinally, the Marine Corps considers amphibious operations and maneuver from the sea as essential to all contemporary and future naval strategy and fundamental to the nature of Marine Corps operations. According to *Marine Corps Doctrinal Publication 3-Expeditionary Operations*:

> The Marine Corps is fundamentally a naval service. Marines are "soldiers of the sea," trained to operate on the sea but to fight on the land. This distinction is more than just historical or cultural—although it is that also. It is first a matter of practical significance. The sea remains the only viable way to deploy large military forces to distant theaters and to rapidly shift forces between theaters. Additionally, in many situations, sea-basing provides a viable, secure option for sustaining expeditionary operations. Given the range of naval aviation, few parts of the globe are beyond the operational reach of naval expeditionary forces today. For a country that possesses naval dominance, the sea becomes an avenue for projecting military power practically anywhere in the world. (United States Marine Corps, 2018)

Through this characterization, the Marine Corps acknowledges the need for power projection in the amphibious arena due to coastal access, rapid build-up of combat power, and sea-basing.

Amphibious armored vehicles have facilitated various types of shore-based entry into areas of operations at scale since the early 20th century. Sea-based connectors have maintained significance since before ancient times, but the ability to push forward and employ Marines and light armored capabilities, at speed, from the beachhead remain a relatively recent advantage for nations with a high degree of maritime power projection and prowess. The sea and land mobility provided by amphibious vehicles historically employed by the Marine Corps, and now the ACV, have become crucial vehicles for the Marine Corps to execute their Title 10 requirement and align with contemporary Marine Corps doctrinal practices.

B. OVERVIEW OF THE AMPHIBIOUS COMBAT VEHICLE

The ACV is an umbrella term for a family of vehicles (FoV) that are capable of embarking and transporting troops and combat equipment from ship to shore and operating ashore for extended periods with appropriate logistics support. At the core of the FoV is an armored eight-wheeled ACV capable of swimming over 12 nautical miles and traversing an additional 400 miles on land (Systems Command, 2024). The ACV FoV consists of four variants covering several mission profiles, including the ACV personnel carrier (ACV-P), ACV command and control (C-2) (ACV-C), ACV recovery (ACV-R) and ACV 30mm cannon (ACV-30) (Deputy Commandant, 2019). This differs from the contemporary AAV FoV which only has three variants in use with equivalents in the ACV FoV (personnel, command, and recovery). The ACV-P is primarily for troop transport and the main variant currently fielded to the fleet, in particular the 3d AABn. The ACV-C is outfitted to serve C2 roles under armor with beyond line of sight and integrated network on the move capabilities. As of March 2024, the ACV-C is beginning to be fielded to fleet units (Marine Corps Systems Command, 2024). The remaining two variants have yet to enter full-rate production as of the date of this publication. The ACV-R is a recovery and maintenance variant designed to assist in towing, retrieval, and maintenance of other ACVs in theater. The ACV-30 is another troop transport variant similar to the ACV-P, while also equipped with a 30mm turret-mounted cannon capable of providing increased direct fire support. The ACV-30 is the only variant which does not have an AAV legacy equivalent (Deputy Commandant, 2019). Figure 1 showcases the four ACV variants as advertised by BAE.

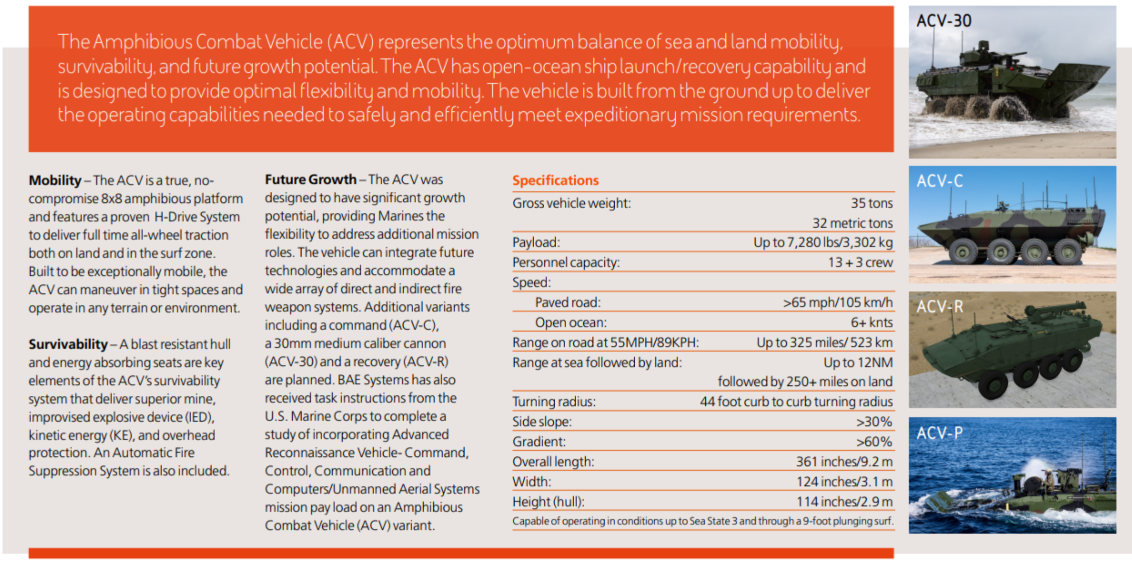


Figure 1. Amphibious Combat Vehicle. Source: BAE Systems (2018).

There are several distinct differences between the ACV platform and the legacy AAV, apart from design age, that factor into its adoption and performance comparisons. Troop carrying capacity, as mentioned above, was reduced from 21 personnel in the AAV to 13 per ACV-P. This reduction also translates to maximum cargo capacity, with a reduction from 10,000 pounds to 6,400 pounds. The AAV is a tracked system like its predecessor the landing vehicle tracked series, while ACV mobility is achieved using eight wheels with run-flat tires (Marine Corps Tactical Systems Support Activity (MCTSSA), n.d.). Iveco's H-Drive system allows the wheels to be independently driven and simulate the handling of a tracked vehicle, as well as leave room for a V-Shaped hull to improve blast protection (Eckstein, 2015). Both the AAV and ACV have comparable speeds through the water at a maximum of around six knots (7 mph) (MCTSSA, n.d.). The ACV has the speed and range advantage over land. The AAV has a maximum over land speed of 45 mph with a range of 200 miles at 25 mph over flat terrain. The ACV has a top speed of 65 mph on land with a range in excess of 400 miles at 43.5 mph. The ACV achieves this despite being significantly heavier than the AAV. A combat-loaded

AAVP7A1 with 21 troops embarked weighs approximately 58,489 pounds (26.5 tons). An ACV-P with 13 troops embarked and a similar combat load weighs 70,771 pounds (32.1 tons) (MCTSSA, n.d.). Figure 2 provides a visual comparison of the AAV and ACV.

Figure 2. AAV (left) and ACV (right). Source: MCTSSA (n.d.).

C. CURRENT ASSAULT AMPHIBIAN BATTALION MODEL

The Marine Corps employs Assault Amphibian Battalions (AABn) as separate battalion structures that are organic to each Marine Division, with some exceptions regarding the unit deployment program (UDP) (U.S. Marine Corps, 2023). There are currently two active-duty battalions (2d and 3d AABn) and one reserve battalion (4th AABn). Battalions break down into companies and further into platoons, which are the basis for the required number of vehicles defined by the current table of organization and equipment (TO&E). Platoons that are currently fielding the AAV are responsible for 12 vehicle systems each along with a general support section under the headquarters platoon fielding 10 systems required for additional mission requirements, to include vehicle towing to a maintenance collection point. Each company maintains at least three platoons, or enough vehicles to move an infantry company in a singular movement as depicted in Figure 3 (U.S. Marine Corps, 2023).

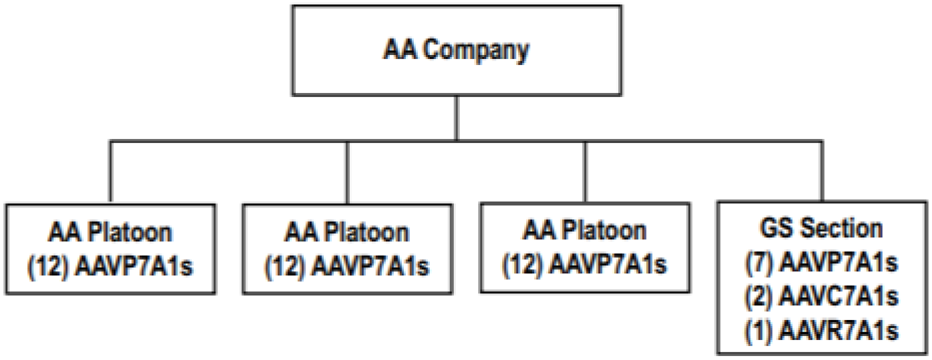


Figure 3. AA Company Organizational Chart. Source: U.S. Marine Corps (2023).

Maintenance is conducted via two methods within the AAV company. First, field maintenance can be conducted by qualified mechanics aboard the crew of singular AAVs to facilitate operational necessity and mission requirements while detached from the company or conducting operations in a forward area. This is a common practice for most vehicles utilized by the United States military to some capacity, with limits tailored by system design and regulations due to required support equipment and its availability. The second method involves the maintenance platoon organic to each company. This platoon is responsible for organizational and limited intermediate level maintenance. This platoon can be further augmented by assets from the battalion level to facilitate maintenance response and readiness increases (U.S. Marine Corps, 2023).

The ACV, according to the Capabilities Development Document, was meant to fall into this current model without any modifications to organizational structure, with the key exception being the allotted number of systems for each platoon (Deputy Commandant, 2019). The ACV, while more advanced and with similar capabilities to the AAV, has less carrying capacity for troops than the current AAV. The AAV has a maximum carrying capacity of up to 21 combat-loaded Marine infantrymen, while the ACV is limited to 13. This disparity requires an adjustment of required vehicles for each AA platoon to meet mission requirements, specifically the ability of each AA company to embark and transport a Marine infantry company. Platoons fielding the ACV are now responsible for 18 vehicles, vice the 12 required when fielding the AAV. This increase is a singular change in the AABn TO&E, with no changes in number of companies, platoons, or sections. An increase in personnel commensurate to the number of available crews was required to facilitate the increase; however, there was no marked increase in the size or capability of maintenance platoons or maintenance-trained personnel available at the battalion level.

D. PROGRAM HISTORY

The ACV was envisioned to partially, and potentially fully, replace the Marine Corps' aging AAV that has been in service with the Marine Corps since 1972. The ACV is intended to enhance AAV capabilities regarding water and land mobility, lethality and force protection (Government Accountability Office [GAO], 2018). The Marine Corps first tried to develop the Expeditionary Fighting Vehicle (EFV) as the AAV replacement but experienced significant schedule delays and cost overruns which ultimately led to the project cancellation in 2011 (GAO, 2018). Without a replacement vehicle, the AAV would be subject to a new round of upgrades to extend the life of the then nearly 40-year-old system. The issue of a suitable replacement remained unresolved, with some questioning the relevance of an armored amphibious landing vehicle in an age of increasingly deadly and difficult to counter threats that would make contested beach landings less viable. The Marine Corps would settle on an updated amphibious system with similar yet superior capabilities, particularly in information systems and modularity (Joint Requirements Oversight Committee [JROC], 2011).

In 2018 the Marine Corps awarded the final contract for the ACV to BAE Systems over Science Applications International Corporation (SAIC) as a determination of "best value," which included cost as well as technical specifications to determine suitability (LaGrone, 2018). The ACV was to be delivered via an "incremental" approach, with versions delivered for initial testing, training, and operational use as more capable and complex variants would enter low-rate initial production (LRIP). The first version, ACV 1.1, was, in fact, not yet capable of amphibious operations, and this would instead be relegated to a capability of ACV 1.2 as BAE made modifications to the existing design (LaGrone, 2018).

It should be noted that BAE is not the sole designer and manufacturer of the ACV. BAE partnered with Iveco Defence Vehicles in 2011, whose "SUPERAV 8x8" platform is what the ACV is based on (Iveco Defence Vehicles, 2024). Iveco, and not BAE, maintains the design authority and intellectual property of the baseline system (Iveco Defence

Vehicles, 2024). Iveco markets its SUPERAV internationally and the ACV system is being considered for allied militaries like Spain (CE Noticias Financieras, 2023). BAE remains the prime regarding contracting with the Marine Corps and support structure for the ACV system.

E. GOVERNMENT ACCOUNTABILITY OFFICE REPORTS

After the historic failure of the EFV development which cost the government $3.7 billion, the Fiscal Year (FY) 2014 National Defense Authorization Act (NDAA) mandated the GAO annually review and report on the ACV program until 2018 (GAO, 2018). The last GAO report from the FY 14 NDAA mandate, GAO-18-364, noted that ACV program officials were considering entering production with manufacturing maturity levels that fell below the standards outlined in Department of Defense (DoD) guidelines or the best practices identified by GAO. GAO recommended the Marine Corps not proceed to the second year of low-rate production for the ACV until confirming the contractor achieved a manufacturing readiness level (MRL) of eight and "not enter full-rate production until achieving an overall MRL of nine" (GAO, 2018). GAO's recommendations were aimed to mitigate future program risks such as quality issues, cost growth, and schedule delays if the proposed actions were taken.

F. CHAPTER SUMMARY

The role and significance of the ACV will continue to increase as the Marine Corps transitions the aging AAV platform out of the fleet. The AABn structure will play an important role in sustaining the readiness of the ACV as the fleet adjusts in real time to a fundamentally different reliability and maintenance frequency of the new platform. This chapter covered the amphibious operations model used by the Marine Corps today and how AABns fit into that structure. An overview and detailed specifications of the ACV were reviewed and compared to the legacy AAV. Additionally, the ACV program's history, and related reports from the GAO were discussed. The next chapter discusses relevant literature regarding reliability and material readiness.

THIS PAGE INTENTIONALLY LEFT BLANK

III. LITERATURE REVIEW

In this section, system reliability and maintenance categories are covered to better understand operational readiness. Additionally, fielding of the V-22 Osprey, a tiltrotor military transport and cargo aircraft, is discussed and compared to the challenges being faced by the ACV.

A. RELIABILITY

Reliability is defined in the *Electronic Reliability Design Handbook* (MIL-HDBK-338B) as "(1) The duration or probability of failure-free performance under stated conditions. (2) The probability that an item can perform its intended function for a specified interval under stated conditions" (U.S. DoD, 1998). In *Logistics Engineering and Management,* Benjamin S. Blanchard goes on to further explain the direct correlation between reliability and the frequency of maintenance stating, "As the reliability of a system increases, the frequency of maintenance will decrease and, conversely the frequency of maintenance will increase as system reliability is degraded" (Blanchard, 2004, p. 47). Maintainability is an inherent design characteristic associated with the ease, ability and time required to keep a system in an operational status and takes into consideration factors such as labor-hours, requirement for specialized equipment, maintenance frequency and cost (Blanchard, 2004). Blanchard additionally introduces the term *availability*, which is often a key measure of a system's performance and a function of reliability and maintainability (Blanchard, 2004, p. 46). It is important to recognize the context of, and meaning, the word availability is used to represent, as it's often utilized as "a measure of system *readiness* (i.e., the degree, percentage, or probability that a system will be ready or available when required for use)" (Blanchard, 2004, p. 72). The availability measure should also be related to the specific scenario or mission the system is required to complete (Blanchard, 2004, p. 72).

Maintenance actions are typically divided into two categories: corrective maintenance (CM) and preventative maintenance (PM). CM refers to unscheduled maintenance actions required after a defect, failure, or perceived failure, in order to restore a system to a specified level of performance. CM may include repair actions such as diagnosing or troubleshooting an issue, disassembly, removal, repair, replacement, adjustment, or assembly. PM, on the other hand, is conducted on a scheduled basis (time, mileage, cycles, etc.) to maintain a system's performance, or prevent an issue from occurring. Examples of pm may include changing vehicle fluids such as engine oil and transmission fluid, rotating tires, conducting calibrations, inspections and replacement of designated items (Blanchard, 2004, p.58).

It is important to recognize the relative relationship between failure rate and the life cycle of a new system. Figure 4 illustrates what is known as the bathtub failure rate curve, showing an increased rate of failure during early fielding of a system due to the discovery of previously unknown issues, component variations within the system, immature manufacturing process, debugging, etc. The initially high failure rate of the system decreases over time eventually reaching a steady state of a relatively consistent failure rate. As the system ages, its components wear-out leading to an increased failure rate as the system reaches the end of its life cycle. While the profile of the failure rate curve may vary dependent on the system being analyzed, the bathtub failure rate curve phenomenon serves as a good basis to better understand failure rate trends (Blanchard, 2004, p.51).

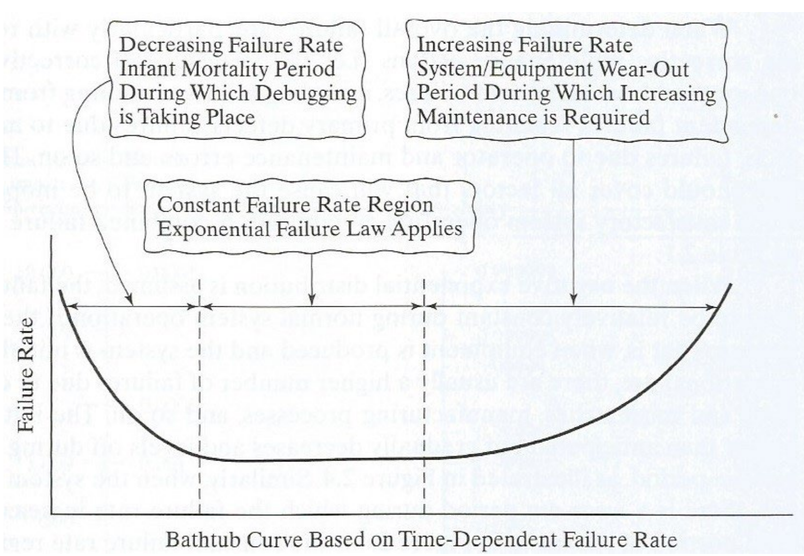


Figure 4. Bathtub Failure Rate Curve. Source: Blanchard (2004)

B. PROBLEM ANALOGUES IN THE V-22 PROGRAM

The immediate comparison to the ACV regarding introduction and fielding issues will likely be its predecessor, the AAV. However, there are more contemporary examples of systems designed for troop transport within the Marine Corps that can provide insight into early struggles regarding readiness and changes to unit organizational structure. The MV-22B Osprey is a prime example (Figure 5).

Figure 5. MV-22B Osprey. Source: Busby (2024)

The MV-22, like the ACV, is a system designed primarily for the amphibious transport of combat troops and are typically embarked on the same ships as the ACV or at least operating within the same Marine Air-Ground Task Force (MAGTF). Also like the ACV, the MV-22 was replacing an aging system with the same core mission set, the CH-46 Sea Knight medium-lift helicopter (seen in Figure 6). Despite similar mission requirements, the MV-22 offered new capabilities due to the differences in design. The MV-22 flies faster, higher, and farther than the CH-46 while carrying a similar payload. These design differences would bring about changes in training and tactics, but initially there were no changes to the organizational structure of the squadrons that began replacing their allotment of Sea Knights and fielding the Ospreys.

Figure 6. CH-46E Sea Knight. Source: Fandom, Inc. (n.d.)

Marine Medium Helicopter Squadron (HMM) organization remained relatively stable since the late Vietnam War. Each HMM was assigned 12 aircraft, each capable of carrying 17–25 combat-loaded Marines with a crew of 5 (CH-46 Sea Knight, 2024). While actual troop capacity was dependent on weight, altitude, and local environmental conditions, this capability is largely in line with AABns following the adoption of the AAV, and both would operate in complimentary roles in the MAGTF for decades. When the MV-22 began introduction across the fleet, squadrons received a name change to Marine Medium Tiltrotor Squadron (VMM), but the organizational structure of the unit remained unchanged. Each squadron was still responsible for 12 aircraft based on the TO&E used for the HMM and the number of maintainers stagnated despite the necessary changes in training to accommodate the new system, which boasted a far more advanced avionics suite and different airframe requirements than the Sea Knight (Knickerbocker, 2017).

The first deployment of an operational VMM was in 2007 (Davis, 2024). Only a few years into the Osprey's initial operational fielding, significant issues were prevalent. Readiness levels sat between 45–58% from FY 2009–2011, with Assistant Deputy Commandant for Aviation Sustainment saying, "It's a bathtub we're in" (Irwin, 2016). This warranted the attention of the then Deputy Commandant of Aviation (DCA), LtGen

Jon Davis. In 2016, LtGen Davis ordered the conduction of an independent readiness review, headed by fellow aviator LtGen Keith Stalder and overseen by Logistics Management Institute (LMI), a consulting firm of business management specialists established under the Kennedy administration (LMI, 2024). The results of the independent review were summarized by LtGen Davis (Ret.):

> The review noted the need to right size maintenance departments with Marine maintainers with the right qualifications. It recommended greater parts availability and reliability and a plan to give the aircraft a common configuration. Most of all, it outlined the funding requirements for those changes. (Davis, 2024)

Initial changes to the program were primarily focused on standardized configurations across all aircraft as well as modifications via engineering change proposals (Doubleday, 2016). Further changes to the program's organizational structure would come from the Marine Corps' Force Design initiative (previously known as Force Design 2030).

Force Design is an ongoing restructuring of the Marine Corps as a whole, including investment in new capabilities, divestment of older and less relevant technologies, and shifts in manpower allocation and evaluation. The effect on the V-22 program was initially a divestment in total squadrons. Three squadrons would be shut down over the course of several years, bringing the total from 17 active-duty squadrons to 14, the underlying idea being to match the Force Design concept of a leaner, more available force (Berger, 2020). There were no plans to change the actual TO&E of each VMM. Shortly after the initiation of this divestment, the Marine Corps pivoted. A planned squadron shutdown on the West Coast was halted, and a previously divested squadron on the East Coast is currently being reactivated (MARADMIN, 2024). This shift coincided with a significant change to the TO&E of Osprey squadrons. The number of aircraft was reduced from 12 down to 10 (Burgess, 2022). While this required a corresponding decrease in the overall number of pilots and aircrew, most of the allocated maintainers remained the same or increased, particularly in the avionics department. This decision discounts the total personnel and cargo capacity of each squadron in exchange for a higher maintainer-to-system ratio and a potential for higher availability. The recency of these changes hinders analysis of their long-term implications; however, another review of the MV-22 is ongoing (Davis, 2024) amidst several fatal crashes along with the significant changes to the TO&E of the VMM.

C. CHAPTER SUMMARY

This chapter discussed the concept of reliability and the relationship of maintenance to the system life cycle. Historical analogues with the Marine Corps' implementation and readiness problems with the MV-22 were also covered. The next chapter covers the methodology used to analyze maintenance data and current staffing models to identify gaps and inefficiencies that contributed to low ACV readiness levels across the fleet Marine force.

IV. METHODOLOGY

This chapter describes the procedures taken to collect, analyze, and interpret the data utilized in this research. Regression, trend, and root cause analyses were primarily utilized to better understand and delineate contributing factors to the ACV readiness levels. Primary sources of data for this research included maintenance service requests, Tables of Organization and Equipment, Capability Development Document, and the ACV FoV Life Cycle Sustainment Plan Version 3.0.

A. SOURCES

The primary means of data collection was through an intermediary request made to the ACV community, in particular subject matter experts who provided the maintenance reports described below for analysis. Other members of the ACV community contributed relevant program documentation and data examined in both analysis and literature review. All documents were shared via Microsoft OneDrive through the Marine Corps Enterprise Network at the Unclassified level.

ACV maintenance service requests and historical maintenance data was collected from Global Combat Support System–Marine Corps (GCSS-MC). GCSS-MC is an enterprise resource planning system described by the Navy Director Operational Test and Evaluation (DOT&E) to provide "all transactional Combat Service Support systems related to supply chain management and enterprise asset management functionality, enabled with service management functions" (DOT&E, 2015). A root cause analysis of ACV maintenance service requests was conducted by analyzing problem codes, severity, and service request summaries to classify the nature of the requests. A trend analysis was utilized to track more than 600 open and 1,870 closed maintenance service requests from November 2020 through August 2024. This was accomplished using pivot tables and statistical calculations. The limitations presented within this data set restricted investigation and conclusions to maintenance requests logged into GCSS-MC during the aforementioned time period. Evaluation of the system used to catalogue and track maintenance data is critical for its utility and accuracy in the proper application of maintenance action as well as future analyses of data that will drive policy and procedures.

The 3d AABn Training, Exercise, and Employment Plan (TEEP) provided a timeline for comparative analysis of maintenance requests. The TEEP is a guiding document that outlines specific events and requirements for a unit's internal planning baseline. The 3d AABn TEEP is specific to that unit and the ACV companies that comprise it. All maintenance actions taken by 3d AABn specifically were measured against their TEEP to explore potential correlations in frequency and type of requests made in GCSS-MC between April and August 2024. The TEEP itself is solely a planning document and not necessarily representative of actual events and training conducted, but necessary for the consideration of maintenance planning, conduct, and inventory management.

TO&E from the Total Force Structure Management System (TFSMS) were analyzed to review command structure, staffing, and equipment levels assigned to the AABn. The TO&E serves as the Marine Corps' authoritative document for force structure and documents the mission statement, manpower requirements and equipment requirements of Marine Corps units (U.S. Marine Corps, 2015). The TO&E for the first ACV equipped Marine Corps' unit, 3d AABn, was compared to the AAV equipped 2d AABn from 2d Marine Division.

The Capability Development Document (CDD) for the ACV Phase 1, Increment 2 (ACV 1.2) FoV and mission role variants (MRV) was analyzed with emphasis on key systems attributes, developmental thresholds and development objectives. A major capability requirement document, the CDD "specifies explicit requirements in terms of developmental performance attributes: Key Performance Parameters (KPPs), Key System Attributes (KSAs), and Additional Performance Attributes (APAs), and other related information necessary to support development of one or more increments of a materiel capability solution" (DoD, 2015).

The ACV FoV Life Cycle Sustainment Plan (LCSP) Version 3.0 was analyzed with emphasis on the product support strategy, maintenance program structure, and supportability analyses. The LCSP serves as the primary program management reference detailing the "product support plan, including sustainment metrics, risks, costs, and analyses used to deliver the performance-based best value strategy covering the integrated product support elements" (DoD, 2021). The LCSP encompasses the entire life cycle of the ACV program from acquisition to disposal and effectively communicates the program's sustainment approach and required resources (Program Executive Officer Land Systems, 2020).

B. CHAPTER SUMMARY

This chapter discussed the sources and methodology used for analysis of ACV maintenance and current staffing requirements. Operational readiness of the ACV is inherently linked to several factors including people, equipment, plans, and policy. This research serves to link relevant ACV maintenance service requests with the TO&E, CDD, TEEP, and LCSP to better understand and address operational readiness shortfalls. The next chapter details the initial findings and observations as well as recommendations for changes and additional research based on that analysis.

THIS PAGE INTENTIONALLY LEFT BLANK

V. ANALYSIS AND FINDINGS

This chapter contains the analysis and findings discovered from this research. The potential root cause of low ACV readiness levels stems from a combination of factors including vehicle reliability, supply chain challenges, unit staffing, and training. Furthermore, a different maintenance approach is required to sustain the ACV compared to the legacy AAV. Significant vehicle characteristics of the ACV differ from its predecessor, with the most obvious being the utilization of eight inflated wheels for land mobility compared to the vehicle tracks utilized on the legacy AAV. Issues originating from the ACV central tire inflation system and struts / shock absorbers have meaningfully contributed to increased part failures resulting in poor reliability and readiness metrics (Berger, 2023). The last significant contribution that compounds these issues is the additional number of vehicles required by each AABn compared to the AAV without a corresponding change to TO&E.

A. GCSS-MC SERVICE REQUESTS AND DEFINITIONS

GCSS-MC is the primary logistics management program used by nearly every unit in the Marine Corps to track various systems and order supplies. Units equipped with the ACV use this program to log maintenance requirements and monitor progress of requests. Two reports were provided from November 2020 to October 2024, one with currently open maintenance requests from all units equipped with the ACV and one with closed requests specifically from 3d AABn (U.S. Marine Corps, n.d). Individual service requests (SR) are categorized by information denoting operational status, job status, severity, problem code, job summary, dates of request creation and modification, the name of the originator, the originating unit, and the unit owner group. A sample of the full data table is provided in Appendix A and a SR process map in Appendix B.

The focus for this analysis was potential correlations between operational status, severity, and problem codes. Each one of these categories is allotted specific descriptions of the nature of the request that are then detailed freely by the user in the summary section.

1. Operational Status

Operational status is divided into four distinct qualifiers for each entry that define the status of the system itself in relation to the request: Supply or Service, Operational–Minor, Operational–Degraded, and Deadlined. Supply or Service generally correlates to issuance of gear or the formality of inventory management and relocation. Operational–Minor implies that the system is fully mission capable with resupply or maintenance required to bring to a normal status. Many requests falling under this code involves modification or verification of systems as well as preventative maintenance checks and services (PMCS). Operational–Degraded implies that a system can perform certain core mission requirements but is not considered fully mission capable. The reasons for this can vary widely, however the problem can remain unresolved without rendering the entire system ineffective. Deadlined is used when the unresolved issue results in the system becoming incapable of performing its core mission functions. Deadlining can also result from a variety of causes but until the underlying request is completed and closed out the system is considered unusable. To deadline an item in GCSS-MC is further defined in UM4000-125 as "To remove materiel or equipment form [sic] operation or use for the one of the following reasons: 1. It is inoperable due to damage, malfunctioning, or necessary repairs 2. It is unsafe 3. It would be damaged by further use" (GCSS-MC, 2020).

2. Severity

Severity is referred to as "priority designator" in the GCSS-MC UM4000-125. It is subdivided into three primary categories that define the nature of the request itself and its priority and further coded based on the Force Activity Designator (FAD), ranking I–V based on locational and deployment, with FAD I denoting units in active combat, FAD II covering units overseas (or maintaining a 24 hour deployable alert status), FAD III for units within the continental United States (CONUS) or stationed outside the continental United States (OCONUS), and FAD IV/V denoting units belonging to Marine Forces Reserve (MARFORRES). The three primary categories are defined and coded by urgency of need. The analyzed report includes the following priority designators: 02 A-Critical, 03 A-Critical, 05 B-Urgent, 06 B-Urgent, 12 C-Routine, and 13 C-Routine. Full explanations of these codes and their relationship to GCSS-MC maintenance requests are provided in Appendix C.

These codes do not necessarily correlate directly to operational status but there are general trends between the two that suggest a relationship between the nature of the request (severity) and the affected system (operational status). This relationship is discussed in Section B. For the purposes of this analysis, severity was categorized entirely by urgency of need descriptors, combining PDs 02 and 03, 05 and 06, 12 and 13.

3. Problem Codes

Problem codes are used to reference a given subsystem that is affected in the request. There are 83 individual problem codes in the analyzed report; however, they generally fall under just 17 related primary codes supplemented by secondary defective codes. The primary codes used by the ACV subsystems include air, armaments, axle, body, component, electric, engine, fire control, fuel, hydraulic, powertrain, steering, suspension, and turret. Two additional codes are used to describe "No Major Defect" (NMAJ) and PMCS. A full list of primary and secondary problem codes, with descriptors, can be found in Appendix D.

4. Limitations

GCSS-MC is not purely a maintenance system, but an all-encompassing logistical enterprise network. This presents it with distinct and relevant limitations regarding root cause analysis. GCSS-MC is susceptible to input errors that are universal to any data gathering system. Requests may be improperly opened, closed, modified, or inaccurate based on the personnel conducting the data entry. This can also produce levels of survivorship bias, wherein an underlying issue may be overlooked due to the lack of available data. For the purpose of moving forward with this research, the data received was analyzed with the base assumption that it was generated correctly and completely.

B. CORRELATION BETWEEN SEVERITY AND OPERATIONAL STATUS

As defined in the Severity Section, the main differentiator between severity and operational status is that severity is an indication of the urgency of need while operational status is a description of the current state of the system. Analysis of the problem codes for each SR was conducted for both correlations with severity and a system's operational status, but for clarification a comparative analysis was performed on SRs to identify the relationship between severity and operational status in both the closed and open SR reports.

Table 1 shows closed SRs for 3d AABn organized by how many of each operational status available fall under the three severity categories.

Table 1. 3d AABn Closed SRs by Operational Status and Severity

Count of Operational Status	Operational Status				
Severity	Deadlined	Operational - Degraded	Operational - Minor	Supply or Service	Grand Total
03 A-Critical	4		13		17
06 B-Urgent	3	19	24		46
13 C-Routine	2	18	1767	19	1806
Grand Total	**9**	**37**	**1804**	**19**	**1869**

The overwhelming majority of closed SRs fall under the severity category of routine, however there is still a positive correlation of operational status and the severity classification, demonstrated in Figures 7 through 9.

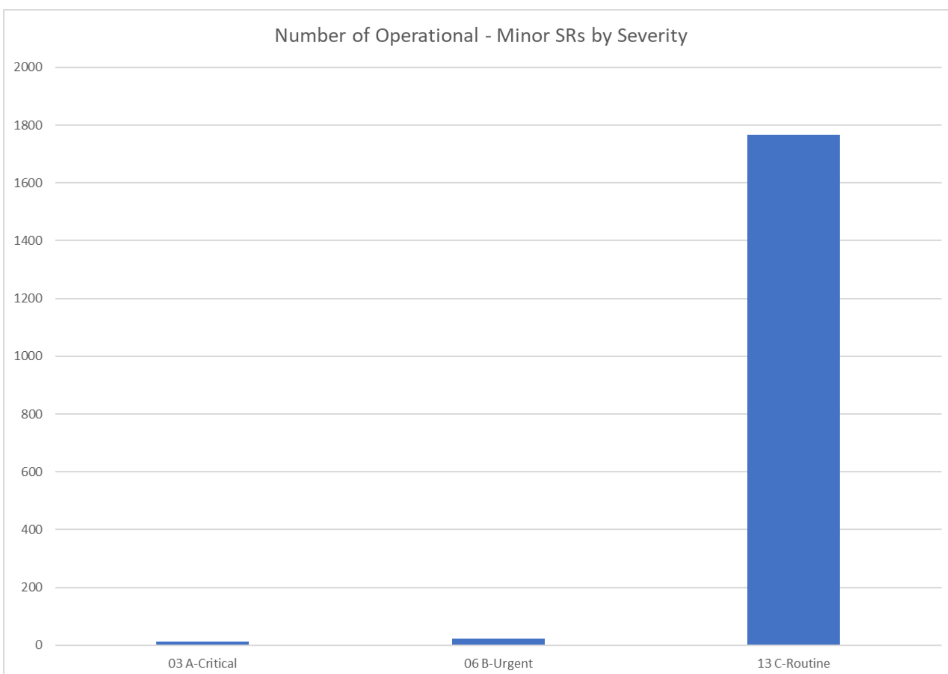
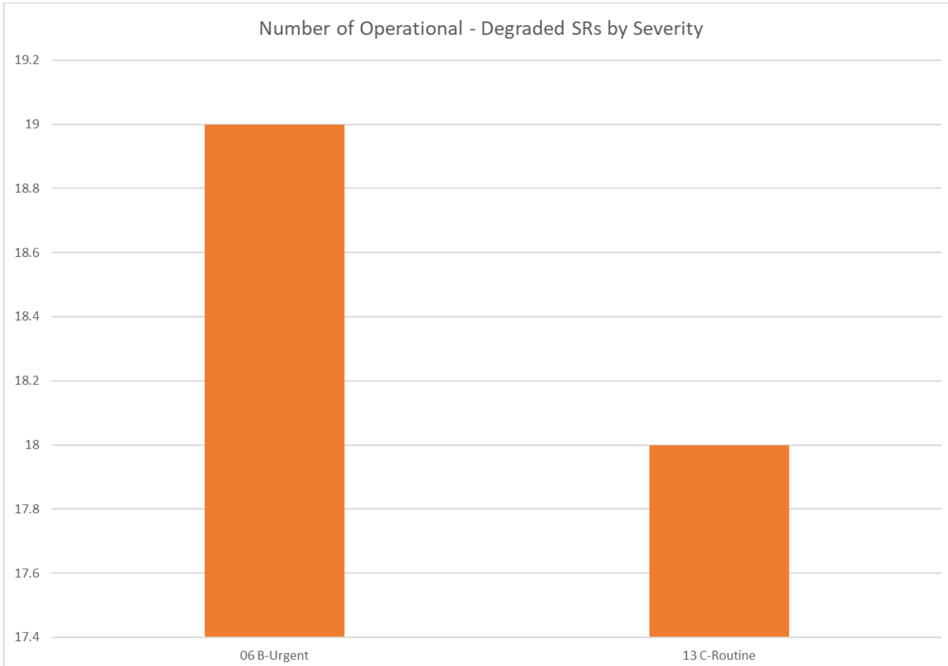


Figure 7. Total Number of Closed SRs, Operational–Minor by Severity Category



Note: No Closed SRs indicating Operational–Degraded were categorized "03 A-Critical"

Figure 8. Total Number of Closed SRs, Operational–Degraded by Severity Category

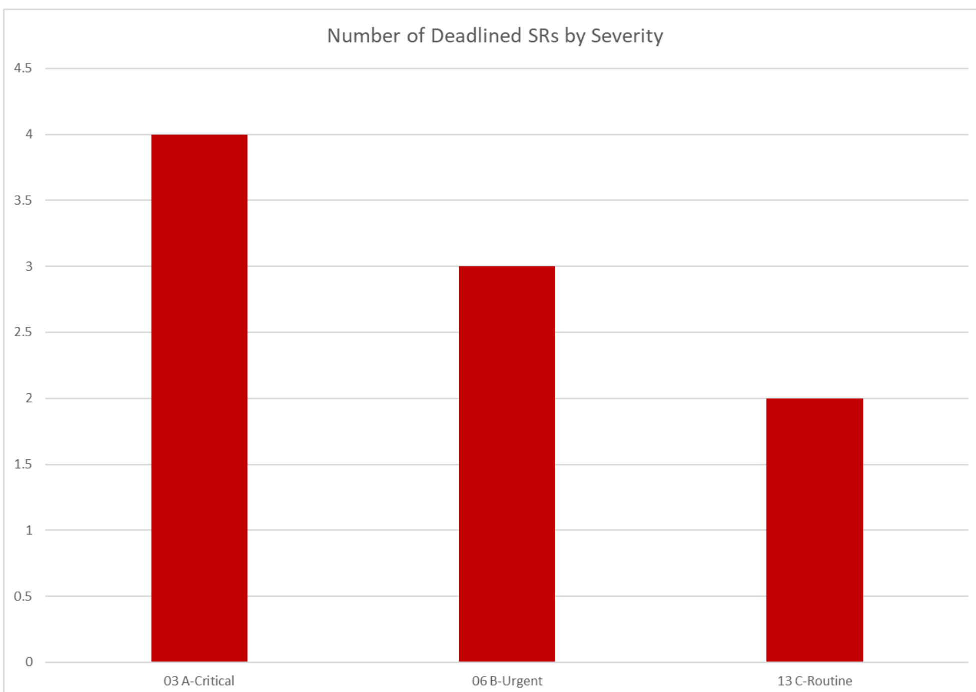
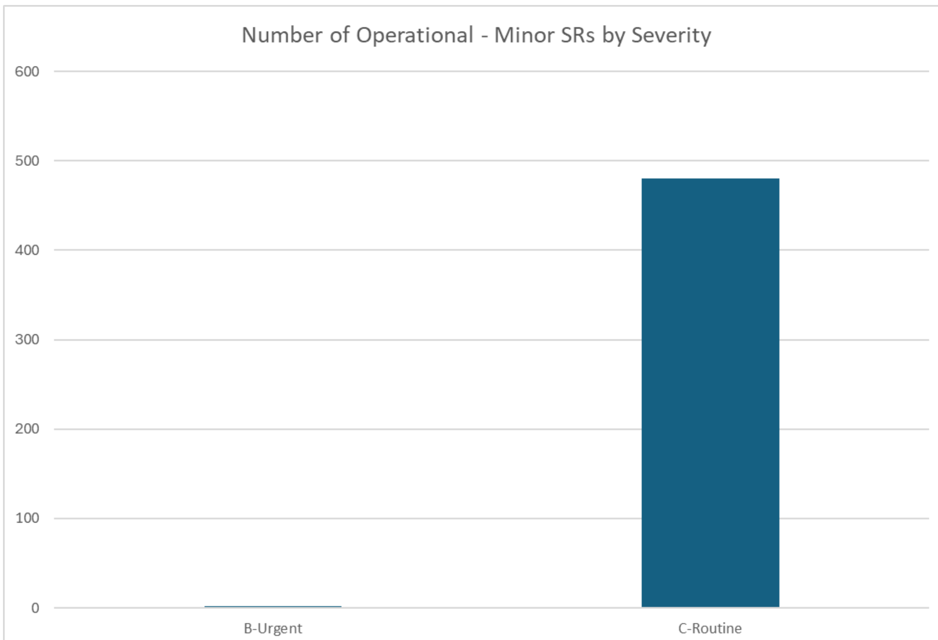


Figure 9. Total Number of Closed SRs, Deadlined by Severity Category

This relationship is more pronounced in the open SR report. Table 2, along with Figures 10 and 11, illustrate this for all open work orders for 3d AABn and other supporting units also equipped with the ACV.

Table 2. Fleetwide Open SRs by Operational Status and Severity

Count of Operational Status	Operational Status				
Severity	**Deadlined**	**Operational - Degraded**	**Operational - Minor**	**Supply or Service**	**Grand Total**
A-Critical	111	1			112
B-Urgent	2	75	2		79
C-Routine		3	480	43	526
Grand Total	**113**	**79**	**482**	**43**	**717**



Note: No Open SRs indicating Operational–Minor were categorized "A-Critical"

Figure 10. Total Number of Open SRs, Operational–Minor by Severity Category

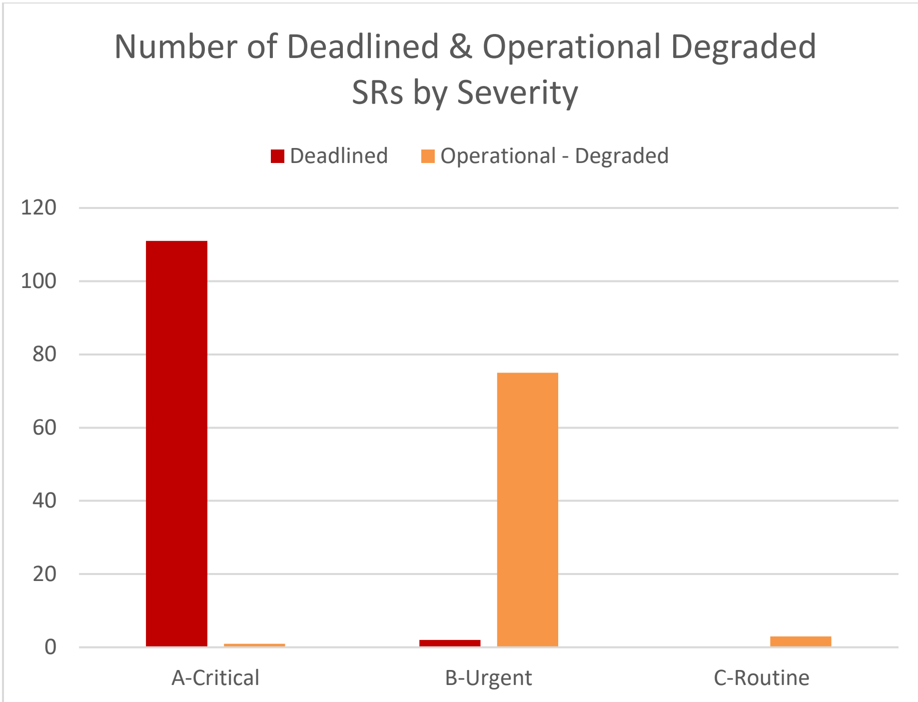


Figure 11. Total Number of Open SRs, Deadlined and Operational–Degraded by Severity Category

This analysis demonstrates that while operational status does not necessarily dictate the severity code assigned to a service request, there is a high positive correlation between the two categories. Understanding this provides the basis for the two primary tiers of analysis going forward. Problem codes were evaluated by the severity categories assigned for both closed and open SRs. Further analysis compared problem codes most commonly associated with each operational status.

C. CLOSED SERVICE REQUESTS

The first data set to be examined specifically addresses closed SRs for only the 3d AABn during the reporting period. While this limits this analysis to a single unit, 3d AABn is currently the largest reporting organization that has fully converted to the ACV from the AAV and is actively using the ACV in an operational and deployable status. There are 1,869 SRs included within this report.

1. Severity and Problem Code Correlations

The majority of requests within this report are categorized under the severity code "C-Routine." This is also true for the report on open requests. The inferred reasoning for this will be further addressed in the section related to specific problem codes and their severity correlation, but this is also understood within the inherit nature of maintenance and the Pareto principle. The Pareto principle is widely known for the concept of an "80/20" rule wherein 80% of work or instances produced is driven by or the result of just 20% of a given population. This also implies the inverse is true, where a majority of instances in a sample (80%) have a substantially lower impact (20%). It is logical to conclude, then, that within the analyzed GCSS-MC reports most SRs would be categorized with the lowest severity category. This is demonstrated in Figure 12 and Table 3 for closed SRs.

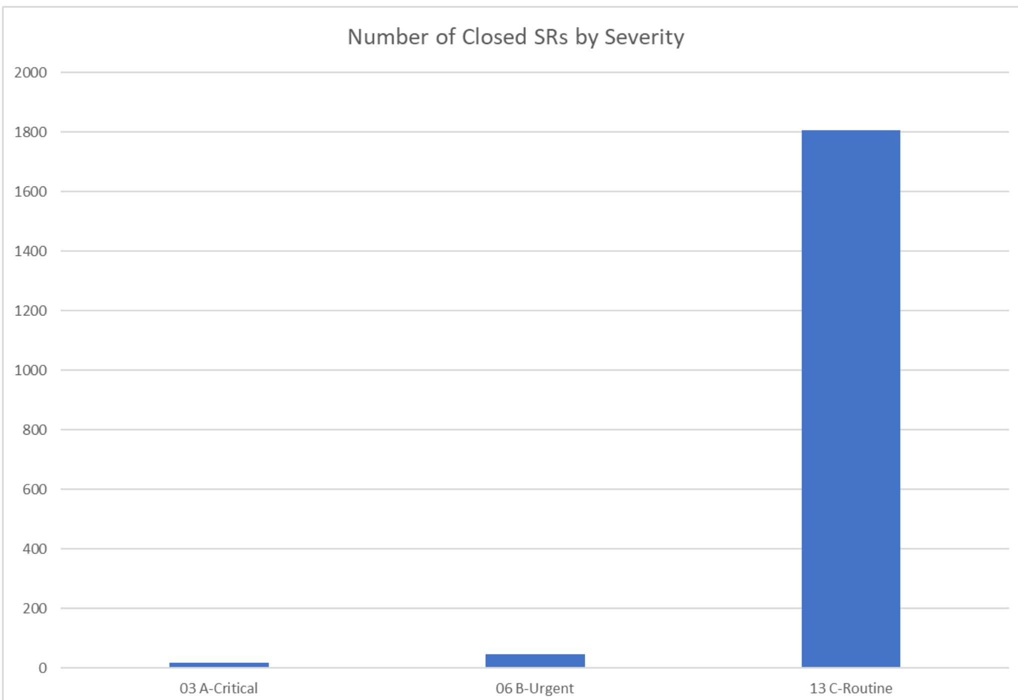


Figure 12. Total Number of Closed Service Requests by Severity Category

Table 3. Number of Closed Service Requests by Severity Category

Severity	Total	%
03 A-Critical	17	0.91%
06 B-Urgent	46	2.46%
13 C-Routine	1806	96.63%
Grand Total	**1869**	

This data concurs with the previous assertion that SRs categorized as "Routine" make up the bulk of inputs. The same will be true for the open SRs discussed later in this chapter.

However, further examination is required to explain this pattern and uncover commonalities within SRs of different categories, open or closed.

Firstly, the data as organized by severity is skewed when problem codes are introduced. Table 4 aggregates every routine SR and organizes them by problem code and number of instances per code.

Table 4. Closed SRs Categorized "C-Routine" by Problem Code Occurrence, All

Problem Code Type	Category Totals	%	Cumulative %
NMAJ	**602**	**33.33%**	**33.33%**
PMCS	**357**	**19.77%**	**53.10%**
(BLANK)	**166**	**9.19%**	**62.29%**
COMP	147	8.14%	70.43%
SUSP	115	6.37%	76.80%
ELEC	108	5.98%	82.78%
BODY	78	4.32%	87.10%
HYDR	67	3.71%	90.81%
AIR	40	2.21%	93.02%
ENG	22	1.22%	94.24%
STEERING	16	0.89%	95.13%
FUEL	15	0.83%	95.96%
DAD1	14	0.78%	96.73%
COOL	13	0.72%	97.45%
AXLE	7	0.39%	97.84%
PWRT	7	0.39%	98.23%
FCON	6	0.33%	98.56%
ARMT	5	0.28%	98.84%
TURR	5	0.28%	99.11%
TRAN	4	0.22%	99.34%
WPNS	4	0.22%	99.56%
IGNI	3	0.17%	99.72%
TEDD	3	0.17%	99.89%
MTR	1	0.06%	99.94%
RCIC	1	0.06%	100.00%

The three problem codes accounting for over 60% of routine SRs aren't related to any of the ACV's actual subsystems. Out of the 602 NMAJ requests, 269 were labeled as NMAJ modification (MODAP) related, and 178 as NMAJ SL3AP, or related specifically to the application or ordering of stock list-3 (SL-3) for the ACV system. PMCS SRs act as recorded logs of annual and semi-annual preventative maintenance inspections. The (BLANK) category specifically refers to SRs without an assigned problem code. There is no specific reason given for the lack of a problem code entry. Investigating the summaries shows that 79 of the 166 entries are purely related to verification of work conducted, an additional 45 were also related to SL-3 replenishment, 21 to selective interchange of parts between vehicles, and 13 verifying a parent-child configuration, terminology used to describe inventory management of system to improve accountability and tracking. The remaining 9 requests didn't fall into any specific category.

Filtering out the problem code categories of NMAJ, PMCS, and (BLANK) produces a clearer picture of the subsystems that produce the most SRs labeled as "routine" depicted in Table 5 and Figure 13.

Table 5. Closed SRs Categorized "C-Routine" by Problem Code Occurrence, Subsystems

Problem Code Type	Category Totals	%	Cumulative %
COMP	**147**	**21.59%**	**21.59%**
SUSP	**115**	**16.89%**	**38.47%**
ELEC	**108**	**15.86%**	**54.33%**
BODY	78	11.45%	65.79%
HYDR	67	9.84%	75.62%
AIR	40	5.87%	81.50%
ENG	22	3.23%	84.73%
STEERING	16	2.35%	87.08%
FUEL	15	2.20%	89.28%
DAD1	14	2.06%	91.34%
COOL	13	1.91%	93.25%
AXLE	7	1.03%	94.27%
PWRT	7	1.03%	95.30%
FCON	6	0.88%	96.18%
ARMT	5	0.73%	96.92%
TURR	5	0.73%	97.65%
TRAN	4	0.59%	98.24%
WPNS	4	0.59%	98.83%
IGNI	3	0.44%	99.27%
TEDD	3	0.44%	99.71%
MTR	1	0.15%	99.85%
RCIC	1	0.15%	100.00%

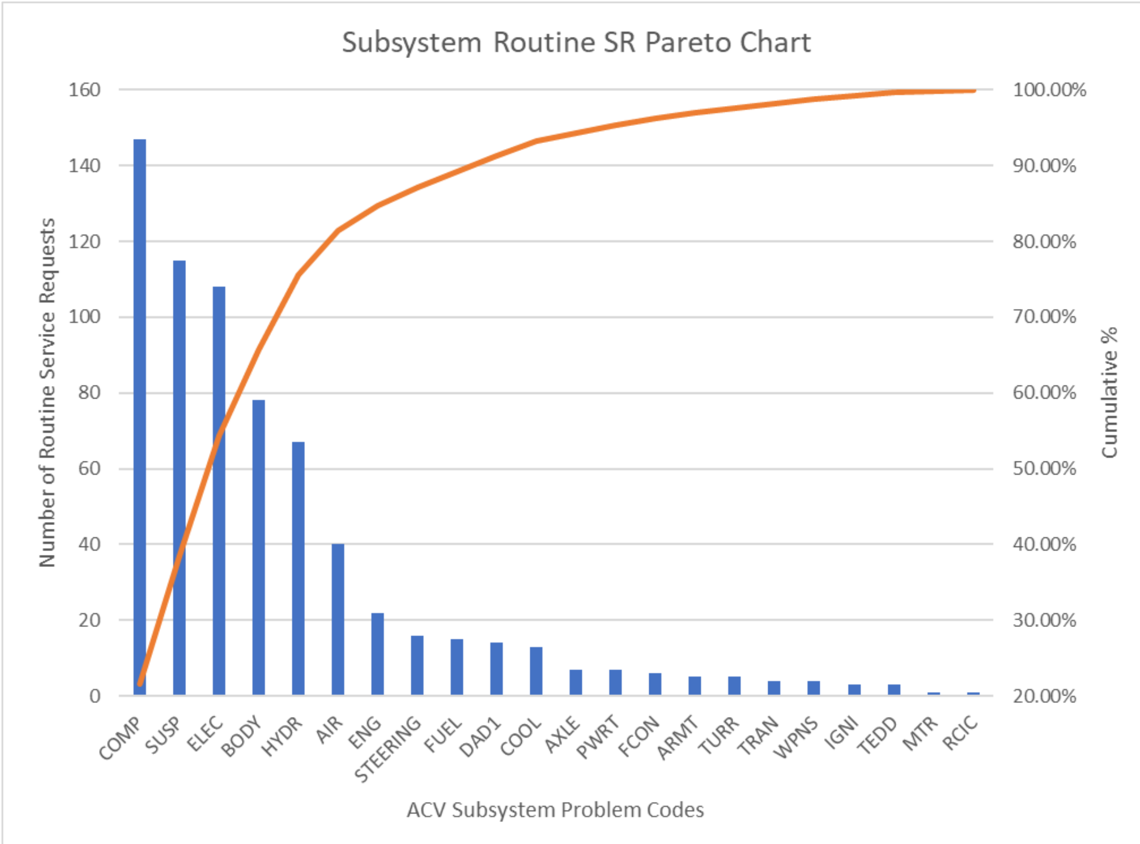


Figure 13. Pareto Chart of ACV Subsystem Closed SRs Categorized "C-Routine"

The three problem codes responsible for more than 50% of all routine SRs related to subsystems are component, suspension, and electrical.

Component, as a problem code, acts as a relative "catch-all" for SRs that do not particularly qualify under the other subsystems. The only way to know the exact issue being addressed in SRs with a component (COMP) problem code is to reference the individual summaries. For this subset of routine SRs, 147 were given the problem code COMP. Of these, 32 SRs (21.77%) were addressing issues with seats or seatbelts, 17 SRs (11.56%) referenced various sensor issues, and another 17 SRs were labeled as "SL3 Replenishment," which was previously referenced under SRs using the NMAJ problem code. The remaining SRs under the COMP problem code did not fall into any specific group in significant numbers.

The suspension and electrical subsystems can be categorized by simpler means, using the secondary defective codes to identify common problems within each subsystem rather than individual components. Of these routine SRs, 115 fall under the suspension subsystem. The most common defect code assigned to the suspension (SUSP) was cracked, broken, or bent (CBB). There were 27 SRs with SUSP CBB as the problem code, 23.48% of routine SRs for the suspension subsystem. The most common defects outside CBB included inoperative (INOP), packing, seals and gaskets (SEAL), springs, shocks and stabilizer components (SPRG), and components out of tolerance (COTO). These accounted for 17 (14.78%), 16 (13.91%), 13 (11.3%), and 12 (10.4%) cases respectively out of the 115 for suspension. The electrical subsystem had a significantly less diverse concentration of defects. Out of the 108 routine SRs for the subsystem, 43 (39.81%) of them were INOP, with another 16 (14.81%) labeled CBB.

For this closed report, there were less SRs given the severity categories of urgent and critical than routine by several orders of magnitude. This is not the case with the open report which will be discussed in the next section. The remaining analysis for severity and problem code correlations is taken as observational rather than conclusive, but still reinforces some of the points addressed during this chapter so far. Table 6 lists the subsystems by number of SRs given a severity of “Urgent” or “Critical” while Figure 14 provides a graphical depiction.

Table 6. Closed SRs Categorized "A-Critical" or "B-Urgent" by Problem Code Occurrence

Problem Code	Category Totals	%	Cumulative
BODY	**10**	**15.87%**	**15.87%**
SUSP	**10**	**15.87%**	**31.75%**
HYDR	**7**	**11.11%**	**42.86%**
ELEC	**6**	**9.52%**	**52.38%**
FUEL	6	9.52%	61.90%
NMAJ	4	6.35%	68.25%
AIR	3	4.76%	73.02%
COMP	3	4.76%	77.78%
ENG	3	4.76%	82.54%
AXLE	2	3.17%	85.71%
IGNI	2	3.17%	88.89%
(BLANK)	2	3.17%	92.06%
COOL	1	1.59%	93.65%
MTR	1	1.59%	95.24%
STEERING	1	1.59%	96.83%
TRAN	1	1.59%	98.41%
TURR	1	1.59%	100.00%

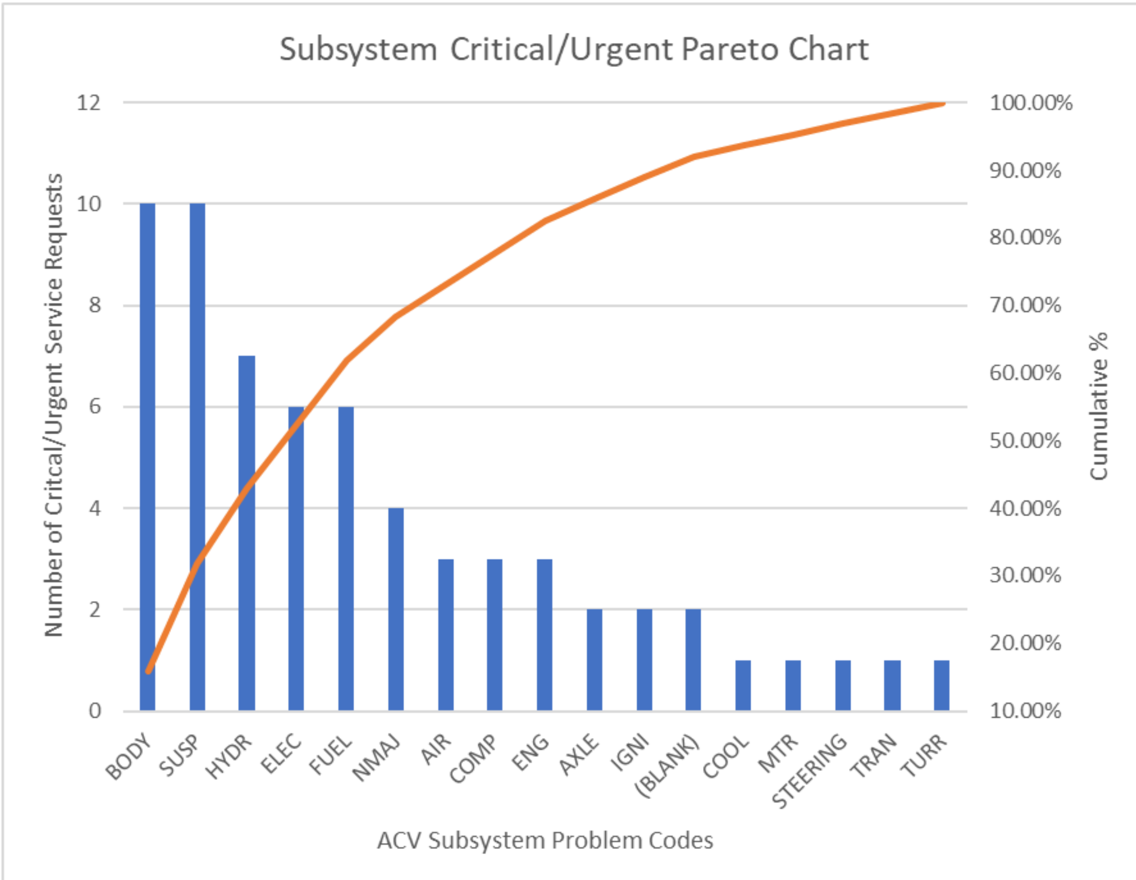


Figure 14. Pareto Chart of ACV Subsystem Closed SRs Categorized "A-Critical" or "B-Urgent"

Of note, several problem code categories did not carry over from the routine SRs: armament (ARMT), data/digital systems (DAD1), fire control systems (FCON), PMCS, powertrain (PWRT), test equipment/display devices (TEDD), and weapons/small arms/crew served (WPNS). The total number of SRs between the critical and urgent severity categories is only 63, but some key observations of this data include both the body and suspension subsystems bearing responsibility for over one third of these cases. Further analysis revealed that the most common defective code for both BODY and SUSP was SEAL, accounting for 50% and 40% of these cases, respectively.

2. Problem Code and Operational Status Correlations

This next analysis identifies the relationship between problem codes within the closed report and the operational status of each SR prior to closeout and resolution of the request. There are many parallels to be drawn between this view of the data in the closed report and that of correlating severity, as addressed in Section B of this chapter.

The first analysis investigated SRs with a system status deemed "Operational–Minor" at the time of closure and the prevalence of the various problem codes across these requests. Of the 1,869 SRs included in the closed report, 1,804 had a status of Operational –Minor. Tables 7 and 8 present a breakdown of these requests by problem code subsystem categories.

Table 7. Closed SRs with Operational Status "Operational – Minor" by Problem Code Occurrence, All

Problem Code	Status Totals	%	Cumulative %
NMAJ	**590**	**32.71%**	**32.71%**
PMCS	**357**	**19.79%**	**52.49%**
(BLANK)	**152**	**8.43%**	**60.92%**
COMP	146	8.09%	69.01%
SUSP	117	6.49%	75.50%
ELEC	111	6.15%	81.65%
BODY	84	4.66%	86.31%
HYDR	71	3.94%	90.24%
AIR	42	2.33%	92.57%
ENG	25	1.39%	93.96%
FUEL	20	1.11%	95.07%
STEERING	16	0.89%	95.95%
DAD1	13	0.72%	96.67%
COOL	12	0.67%	97.34%
AXLE	8	0.44%	97.78%
PWRT	7	0.39%	98.17%
ARMT	5	0.28%	98.45%
FCON	5	0.28%	98.73%
TRAN	5	0.28%	99.00%
TURR	5	0.28%	99.28%
IGNI	4	0.22%	99.50%
WPNS	4	0.22%	99.72%
TEDD	3	0.17%	99.89%
MTR	2	0.11%	100.00%

Table 8. Closed SRs with Operational Status "Operational–Minor" by Problem Code Occurrence, Subsystems

Problem Code	Status Totals	%	Cumulative %
COMP	**146**	**20.71%**	**20.71%**
SUSP	**117**	**16.60%**	**37.30%**
ELEC	**111**	**15.74%**	**53.05%**
BODY	84	11.91%	64.96%
HYDR	71	10.07%	75.04%
AIR	42	5.96%	80.99%
ENG	25	3.55%	84.54%
FUEL	20	2.84%	87.38%
STEERING	16	2.27%	89.65%
DAD1	13	1.84%	91.49%
COOL	12	1.70%	93.19%
AXLE	8	1.13%	94.33%
PWRT	7	0.99%	95.32%
ARMT	5	0.71%	96.03%
FCON	5	0.71%	96.74%
TRAN	5	0.71%	97.45%
TURR	5	0.71%	98.16%
IGNI	4	0.57%	98.72%
WPNS	4	0.57%	99.29%
TEDD	3	0.43%	99.72%
MTR	2	0.28%	100.00%

With all problem codes accounted for, as well as controlling for the NMAJ, PMCS, and (BLANK) codes as done previously, the results are extremely similar to the correlation between problem codes and severity "C-Routine." This reinforces the positive correlation between severity and operational status identified earlier as well as accounts for the subsystems responsible for the majority Operational–Minor system statuses.

There are correspondingly less SRs falling under an operational status of "Deadlined" or "Operational–Degraded" than even those categorized by the highest two severities. There are still relevant observations as to the problem codes associated most with these statuses. Table 9 displays this relationship.

Table 9. Closed SRs with Operational Status "Deadlined" or "Operational– Degraded" by Problem Code Occurrence

Problem Code	Status Totals	%	Cumulative %
NMAJ	**14**	**30.43%**	**30.43%**
SUSP	**8**	**17.39%**	**47.83%**
BODY	**4**	**8.70%**	**56.52%**
COMP	3	6.52%	63.04%
ELEC	3	6.52%	69.57%
HYDR	3	6.52%	76.09%
COOL	2	4.35%	80.43%
AIR	1	2.17%	82.61%
AXLE	1	2.17%	84.78%
DAD1	1	2.17%	86.96%
FCON	1	2.17%	89.13%
FUEL	1	2.17%	91.30%
IGNI	1	2.17%	93.48%
RCIC	1	2.17%	95.65%
STEERING	1	2.17%	97.83%
TURR	1	2.17%	100.00%

Further investigation shows that of the SRs in Table 9 using the problem code NMAJ only two were not related to SL-3, and none were given a "Deadlined" status. Foure out of the eight SRs under the suspension subsystem problem codes were deadlined. The suspension subsystem was also the only subsystem with multiple SRs given the operational status of "Deadlined" in this report (nine in total).

3. Additional Observations

Two additional analyses were made of the closed SR report that add context to the data presented. The first was a complete aggregation of SRs for each serialized system. In the closed report, there are 152 unique serials used matching each ACV system owned by 3d AABn with at least one closed SR during the reporting period (analysis excluded the "Supply or Service" operational status). The minimum number of closed SRs across all systems was one, with the maximum number being 31 and a median of 13. The average number of closed SRs was 12.2 with a standard deviation of 6.5. Figure 15 provides a graphical representation of this data.

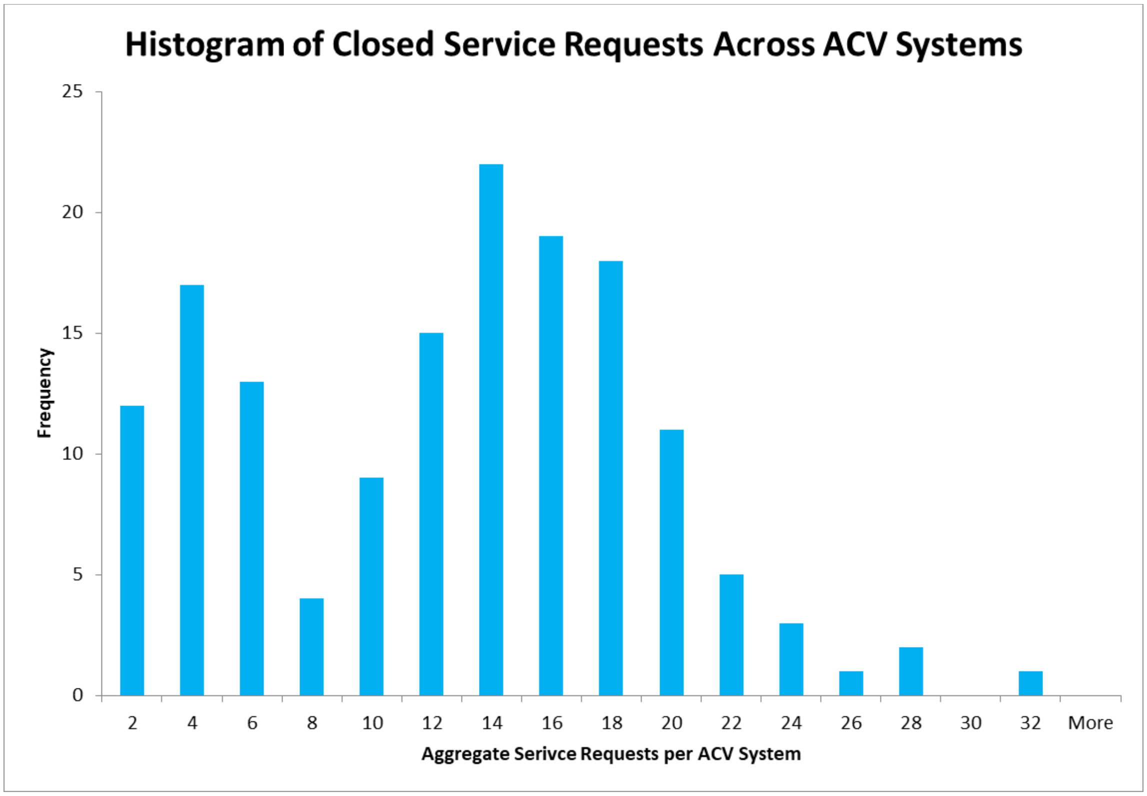


Figure 15. Histogram of Aggregated Closed Service Requests Across Individual ACV System Serials

At the high end at least 20 separate systems had approximately 14 service requests during the reporting period that were closed out. Another observation of the data showed 29 unique serials accounting for the 36 closed SRs with a status of "Operational – Degraded" and seven unique serials accounting for the nine closed SRs with a status of "Deadlined." The conclusion drawn from this data set, and was also noted for the open SR report, is that the load of requests is shared throughout the 3d AABn pool of ACVs, and that no one particular system is skewing the data unevenly.

The last observation made for the closed report was an analysis of resolution time for SRs. This was broken down by severity categories to draw any distinctions between urgency of need for each SR and how long it took from date of creation to closure of the request. Table 10 provides the descriptive statistics of the reported days open for each request.

Table 10. Closed SR Days Open Descriptive Statistics

Closed SR Report	Days Open					
	Max	Min	Median	Mode	Mean	Standard Deviation
All Requests	803	0	30	0	89.01	122.46
A-Critical	301	0	53	0	74.12	85.22
B-Urgent	803	0	104.5	0	153.11	163.20
C-Routine	708	0	30	0	88.04	121.40

The first observation is the minimum and mode entries of 0 for every severity category. There are several characteristics related to GCSS-MC that account for this. Any entry that does not surpass a full 24 hours from request opening to closure is counted as 0 under "Days Open." It is entirely possible that some work requests can be resolved in this timeframe, including systems that are deadlined. What accounts for the mode in each category is the fact that 224 of the total requests in the report logged 0 for days open. Controlling for this indicates the second most common entry is 1, and the third being 6. A plausible explanation for this is that entries into GCSS-MC are only being made as the work is actively completed, rather than when the issue first arose as a purely administrative requirement. Without knowing the actual prescribed length of time for each maintenance item, it is impossible to determine how many times this is the case.

The other large factor in this data is the extremely high maximum logs that skew the average and standard deviation of each category. In this case, the median is likely the most accurate measure and is reflected graphically in Figure 16.

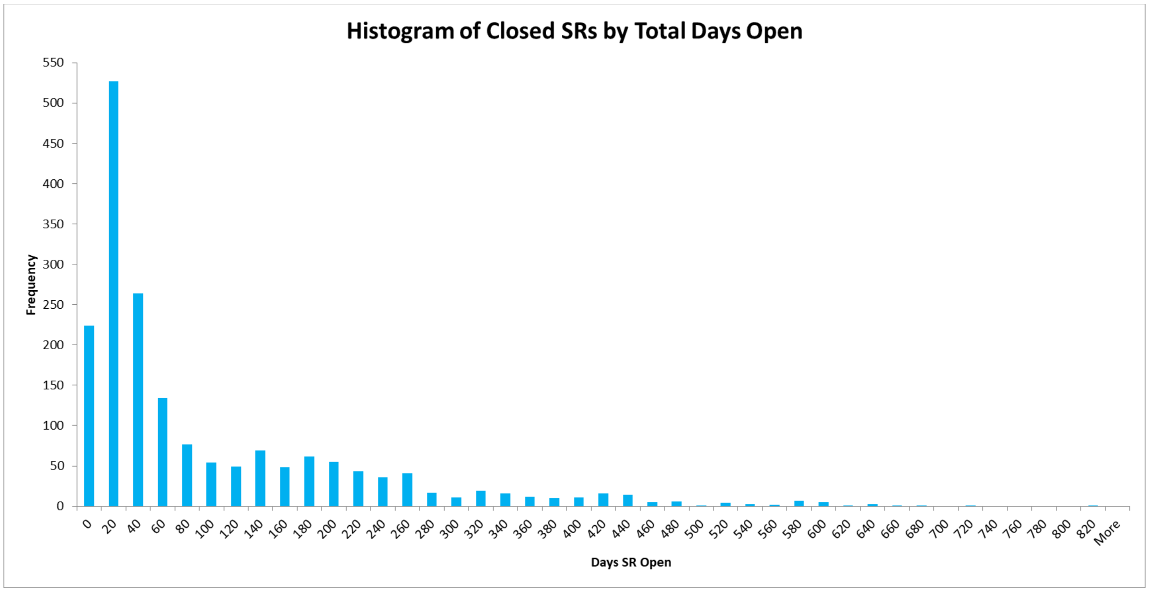


Figure 16. Histogram of Closed SR Frequency of Total Days Open Before Closeout

Most requests take less than 60 days to resolve across all severities, but the averages are driven by significant outliers with the longest requests taking beyond two full years (730 days). The reasoning for this cannot be determined with the data available in this research.

D. OPEN SERVICE REQUESTS

The second data set represents SRs that remained open as of October 25, 2024 for all units currently fielding the ACV: 468 of 717 total requests (65.3%) belong to 3d AABn, with several requests falling under unit detachments reporting to 1st Battalion, 5th Marine Regiment (V1/5) and the 4th Marine Regiment in support of exercises and training. 149 requests belong to the Assault Amphibian School (AAS) located in Camp Pendelton, California, and the remaining 27 requests are split between Marine Corps Systems Command (MARCORSYSCOM), Marine Corps Logistics Command (LOGCOM) and MCTSSA; U.S. Marine Corps, n.d). The status of these requests as of the distribution of this document is unknown. Focused analysis was restricted to open requests falling under 3d AABn, with additional observations conducted on SRs belonging to V1/5, 4th Marine Regiment, AAS, SYSCOM, LOGCOM, and MCTSSA. The method of analysis of this data set is identical to the previous data set of closed SRs.

1. Severity and Problem Code Correlations

As alluded to in the previous section, the bulk of SRs open as of October 25th, 2024, fall under the severity category of "C-Routine." What differs in this report is the ratio by which they compare to the other two categories. Figure 17 and Table 11 show the breakdown of open SRs created by 3d AABn by severity code.

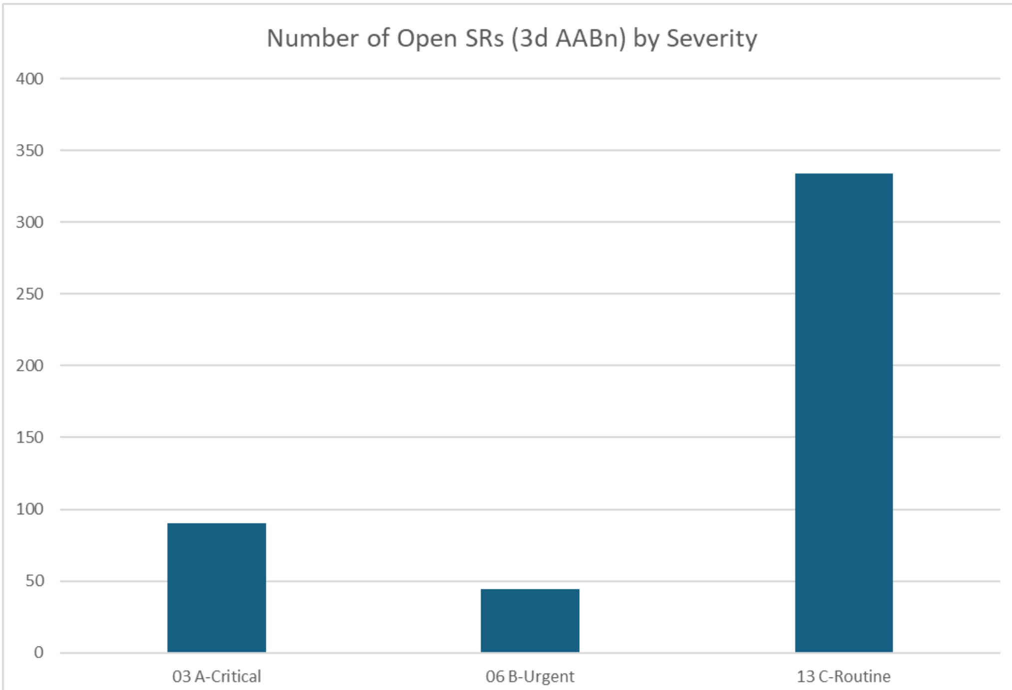


Figure 17. Number of 3d AABn Open SRs by Severity Category

Table 11. Number of 3d AABn Open SRs by Severity Category

Severity	Total	%
03 A-Critical	90	19.23%
06 B-Urgent	44	9.40%
13 C-Routine	334	71.37%
Grand Total	**468**	

Despite the smaller sample size, the aspects of the Pareto principle remain true. In fact, the ratios correspond to the general Pareto distribution much closer than that of the closed SR report. This data can now be broken down by each severity code and reveal correlations with the problem codes applied in this report.

As done previously, the first problem code comparison was conducted on SRs categorized with a severity of "C-Routine." Table 12 provides this breakdown.

Table 12. 3d AABn Open SRs Categorized "C-Routine" by Problem Code Occurrence

Problem Code	Category Total	%	Cumulative %
NMAJ	237	70.96%	70.96%
PMCS	85	25.45%	96.41%
(BLANK)	11	3.29%	99.70%
HYDR	1	0.30%	100.00%

The routine SRs in this report break heavily toward problem codes indicating NMAJ as well as PMCS related requests. NMAJ further breaks down into 98 cases involving MODAP and 104 cases involving SL-3 application (SL3AP). Unlike the closed SR report, nearly every subsystem of the ACV was absent from this list, with the exception of a single SR related to the hydraulic system. The possible reasons for this are numerous but amount to speculation in the absence of data regarding command policies on data entry, work priorities, job timelines, or learning curves. It should be reiterated that the open SR report covers the same time period as the closed report.

There were a total of 44 open SRs for 3d AABn with the severity code "B-Urgent" in this report. While this is comparable in size to the closed SR report, the oldest entries in the closed report date back to 2021, with only four entries in 2024. The oldest urgent SRs in the open report were created in 2023, and 40 of the 44 entries are from 2024 alone. The problem code breakdown for urgent SRs can be seen in Table 13 while Figure 18 shows the Pareto distribution.

Table 13. 3d AABn Open SRs Categorized "B-Urgent" by Problem Code Occurrence

Problem Code	Category Total	%	Cumulative %
SUSP	**21**	**47.73%**	**47.73%**
BODY	**7**	**15.91%**	**63.64%**
COMP	**7**	**15.91%**	**79.55%**
ELEC	5	11.36%	90.91%
AIR	1	2.27%	93.18%
AXLE	1	2.27%	95.45%
FUEL	1	2.27%	97.73%
STEERING	1	2.27%	100.00%

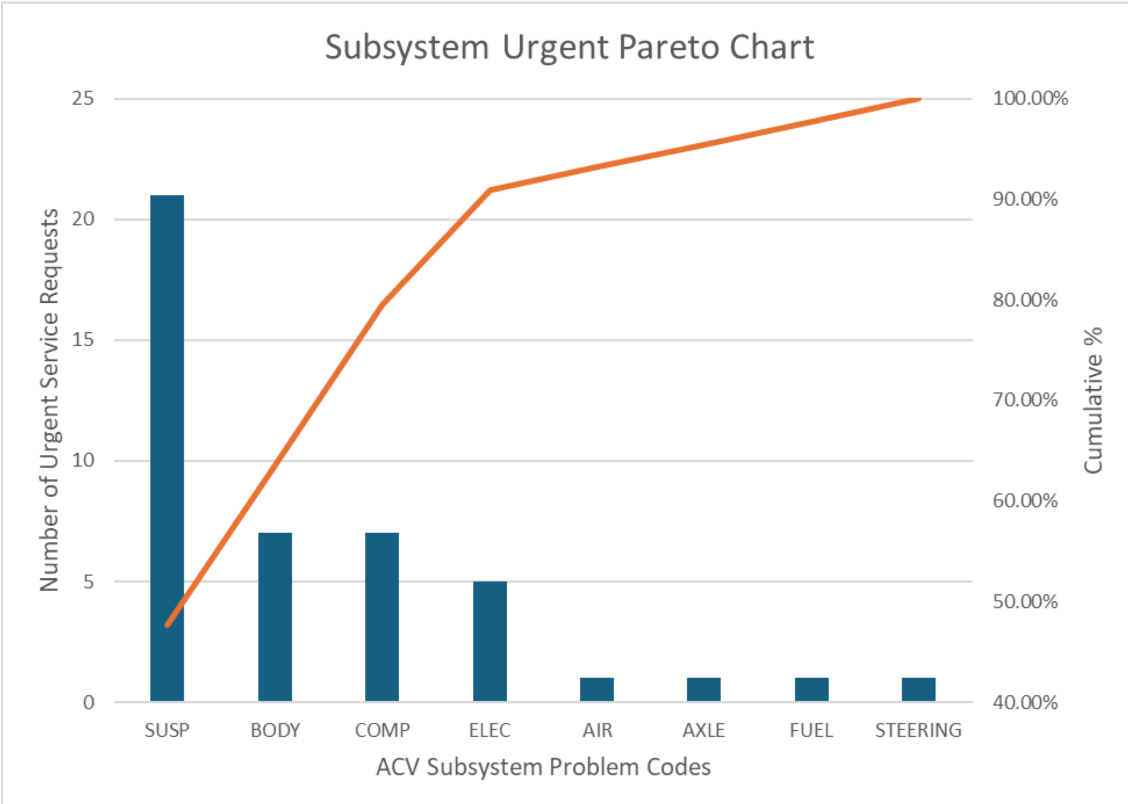


Figure 18. Pareto Chart of ACV Subsystem Closed SRs Categorized "B-Urgent"

Problem codes for the suspension subsystem hold the overwhelming majority of open SRs classified "B-Urgent." Breaking this down further reveals nine SRs (20.5% of the total) falling under the problem code SUSP SPRG. BODY RPLC (a replacement of the body, frame, or hull) holds five urgent SRs in this report (11.4% of the total), with the next highest code being SUSP RPLC at four requests (9% of the total).

The open SRs categorized "A-Critical" have a much higher population than that of urgent, with 90 total open requests. Where these two categories parallel each other is in affected subsystems. Table 14 and Figure 19 provide the breakdown of this data.

Table 14. 3d AABn Open SRs Categorized "A-Critical" by Problem Code Occurrence

Problem Code	Category Total	%	Cumulative %
SUSP	**22**	**24.44%**	**24.44%**
BODY	**20**	**22.22%**	**46.67%**
COMP	**11**	**12.22%**	**58.89%**
HYDR	8	8.89%	67.78%
ELEC	6	6.67%	74.44%
COOL	4	4.44%	78.89%
ENG	4	4.44%	83.33%
FUEL	4	4.44%	87.78%
PWRT	3	3.33%	91.11%
STEERING	3	3.33%	94.44%
AIR	2	2.22%	96.67%
ARMT	1	1.11%	97.78%
AXLE	1	1.11%	98.89%
FCON	1	1.11%	100.00%

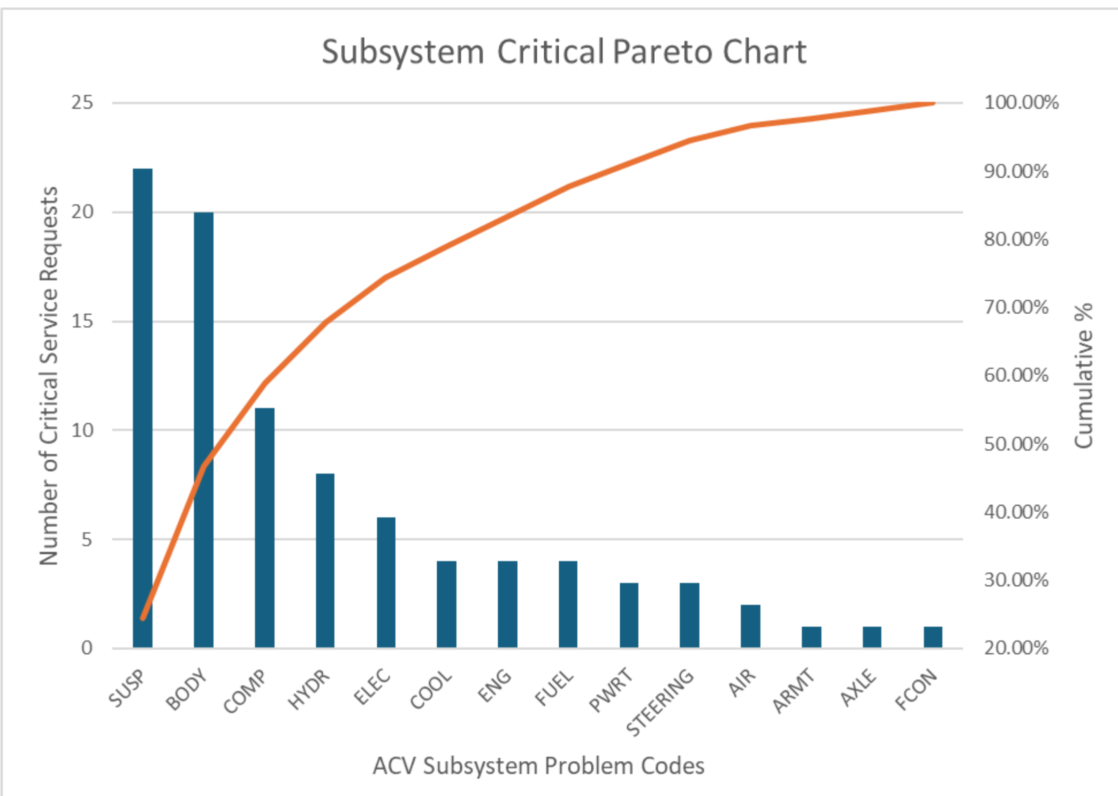


Figure 19. Pareto Chart of ACV Subsystem Closed SRs Categorized "A-Critical"

Like the urgent SRs, suspension, body, and component problem codes represent the lion's share of requests, taking the same rankings in terms of raw numbers as they had previously. The most common defective codes under SUSP were SUSP SPRG and SUSP SEAL, indicating issues with springs, shocks, and stabilizers as well as packing, seals, and gaskets. The remaining requests were relatively evenly distributed among CBB, CORR, COTO, HOSE, INOP, RPLC, and VALV. The BODY problem code demonstrated the opposite scenario, with 13 out 20 requests featuring the defective code BODY SEAL. COMP SRs most commonly held a defective code of CBB, totaling five out of 11 requests. Investigating the summaries of these requests failed to reveal any commonality between issues like those in the closed report. Of note, one request falling under problem code of COMP RPLC featured the longest single summary in the entire report, stating:

> No Power, P4 Tire U/S, P3 Tire Flat, P2 Lug Nuts Missing, P2 Brake Line U/S, S3 Banjo Bolt Missing, Deck Plate Bolts Missing, Cooling Box Bolts Missing, Battery Box Bolts Missing, EELs Inop

This singular SR likely condensed what could have been several separate requests. Without explanation from the individual who made the request, any possible reasoning for consolidating these issues into one SR that can be derived from this data alone would be speculative.

Across all open SRs in 3d AABn categorized as "A-Critical" or "B-Urgent," the suspension system accounted for 43 of 134 requests, or 32.1% of cases. SRs using the BODY problem code over the same population accounted for 27 requests, or 20% of cases. This parallels the analysis of the closed report where both BODY and SUSP coded SRs represented the most frequent issues with severity codes above routine.

2. Problem Code and Operational Status Correlations

This analysis focuses on correlations between problem codes and operational status for the open SR report. It was functionally conducted in the same manner as the closed SR report. The operational status "Supply or Service" was excluded, accounting for only three of the 468 open SRs for 3d AABn, none of which correspond to an ACV subsystem.

Operational–Minor assigned statuses account for 331 of 468 requests, or 70.7% of cases. Table 15 provides the breakdown by problem codes associated with this status.

Table 15. 3d AABn Open SRs with Operational Status "Operational–Minor" by Problem Code Occurrence

Problem Code	Status Totals	%	Cumulative %
NMAJ	235	71.00%	71.00%
PMCS	84	25.38%	96.37%
(BLANK)	10	3.02%	99.40%
HYDR	1	0.30%	99.70%
SUSP	1	0.30%	100.00%

NMAJ and PMCS account for the majority of requests with an "Operational–Minor" status much in the same way they were categorized with the severity "C-Routine." Of note is the request using the SUSP problem code. While maintaining an "Operational–Minor" status, this particular request still fell under a severity of "B-Urgent."

Open SRs with an "Operational–Degraded" status for 3d AABn are the minority aside from Supply or Service. Of 468 requests, only 43 maintain a "degraded" status, or 9.2%. The breakdown of subsystems in Table 16 details the major contributors to this status.

Table 16. 3d AABn Open SRs with Operational Status "Operational–Degraded" by Problem Code Occurrence

Problem Code	Status Totals	%	Cumulative %
SUSP	**19**	**44.19%**	**44.19%**
BODY	7	16.28%	60.47%
COMP	7	16.28%	76.74%
ELEC	4	9.30%	86.05%
AXLE	2	4.65%	90.70%
AIR	1	2.33%	93.02%
FUEL	1	2.33%	95.35%
PMCS	1	2.33%	97.67%
STEERING	1	2.33%	100.00%

The suspension subsystem is nearly three times more common among SRs with this particular operational status than the next subsystem, BODY. nine of the 19 total requests (47.4%) use the defective code SUSP SPRG.

The SRs maintaining "Deadlined" operational status more than double those of "Operational–Degraded." For 3d AABn, there are 91 of 438 SRs (20.8%) with a "Deadlined" status as of October 25th, 2024. Table 17 provides the breakdown of these SRs by problem code while Figure 20 depicts the Pareto distribution.

Table 17. 3d AABn Open SRs with Operational Status "Deadlined" by Problem Code Occurrence

Problem Code	Status Totals	%	Cumulative %
SUSP	**23**	**25.27%**	**25.27%**
BODY	**20**	**21.98%**	**47.25%**
COMP	**11**	**12.09%**	**59.34%**
HYDR	8	8.79%	68.13%
ELEC	7	7.69%	75.82%
COOL	4	4.40%	80.22%
ENG	4	4.40%	84.62%
FUEL	4	4.40%	89.01%
PWRT	3	3.30%	92.31%
STEERING	3	3.30%	95.60%
AIR	2	2.20%	97.80%
ARMT	1	1.10%	98.90%
FCON	1	1.10%	100.00%

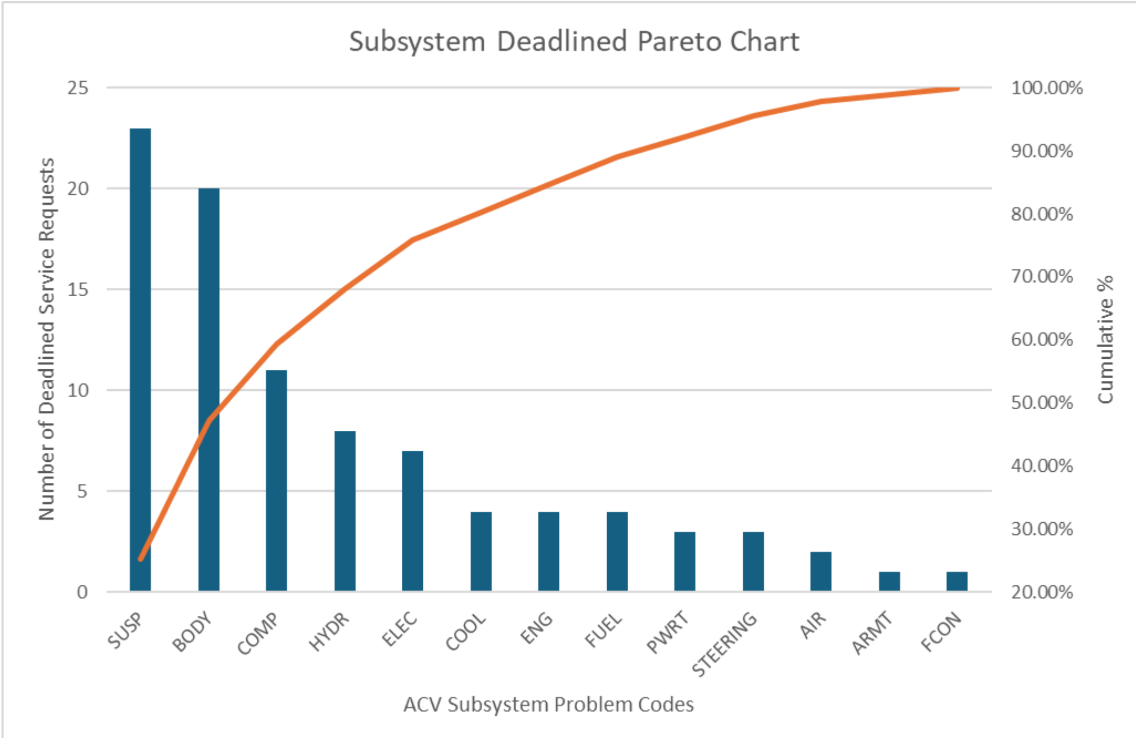


Figure 20. Pareto Chart of ACV Subsystems Open SRs Maintaining Operational Status "Deadlined"

This analysis shows results virtually identical to those found correlating problem code and severity "A-Critical." The suspension and body subsystems break down in the same way, with the most common defective codes being SEAL and SPRG. Suspension issues are, as found previously, spread across several defective codes while body is limited to a majority of problems related to packing, seals, and gaskets.

3. Job Status Correlations

One of the major differences between the closed and open SRs is the addition of a column labeled "Job Status." This column is used to delineate where a request is in the maintenance process and the step that must be completed prior to continuation of work or closing out the request. While an SR remains open, it may be updated and logged under a new job status to indicate progress. For this reason, analysis was made on the correlations between the SR operational status and its indicated job status as of date the report was generated as well as examining the initial date of generation of the SR and subsequent updates.

The first analysis was an aggregate of every applicable job status in the open SR report compared to the total number of requests in 3d AABn. Table 18 and Figure 21 demonstrate the distribution of each job status code utilized.

Table 18. 3d AABn Open SRs by Job Status Occurrence

Job Status	Total SRs	%	Cumulative %
SHT PART	**119**	**25.43%**	**25.43%**
AWTG CTR Support	**98**	**20.94%**	**46.37%**
Approved	**93**	**19.87%**	**66.24%**
SHT FUND	**46**	**9.83%**	**76.07%**
Planned	41	8.76%	84.83%
Waiting Approval	31	6.62%	91.45%
INS PRGS	11	2.35%	93.80%
SHT SPAC	10	2.14%	95.94%
SHT TECH	7	1.50%	97.44%
RPR PRGS	5	1.07%	98.50%
FINL INS	2	0.43%	98.93%
Open	2	0.43%	99.36%
Assigned	1	0.21%	99.57%
EQUIP ACCEPTED	1	0.21%	99.79%
INS COMP	1	0.21%	100.00%

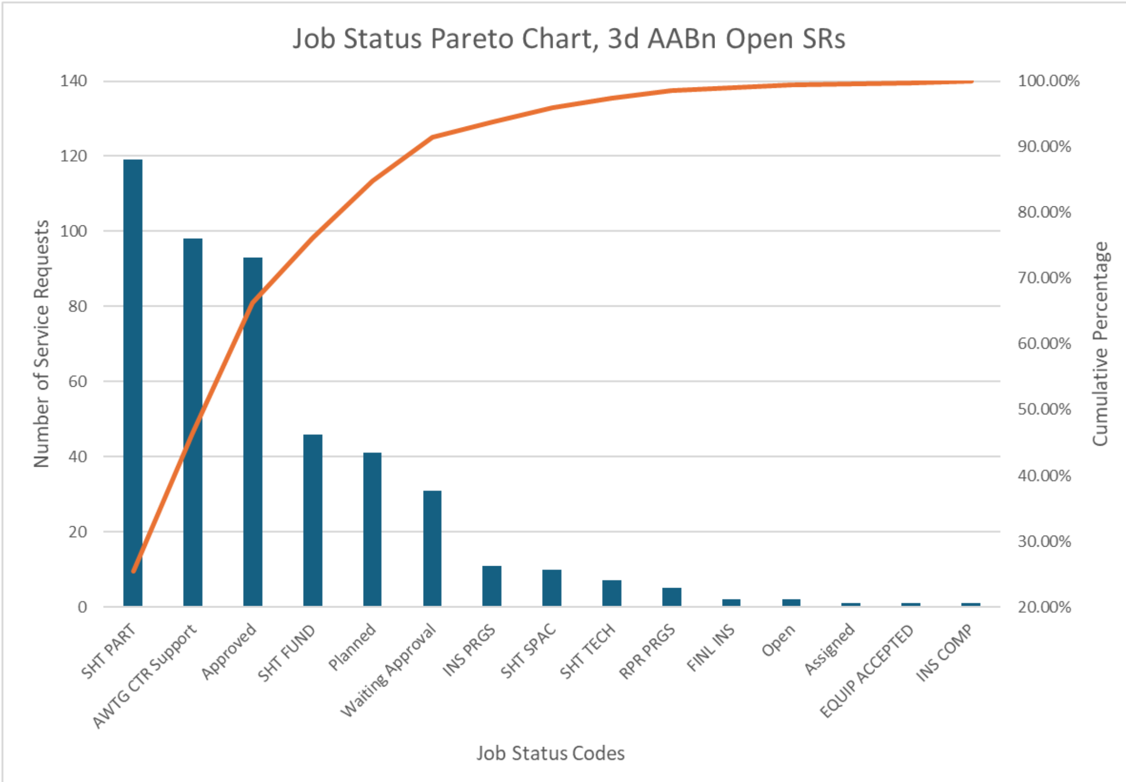


Figure 21. Pareto Chart of 3d AABn Open SRs by Job Status

The first significant observation are the job status codes making up the near majority of SRs between the two of them: Short (SHT) PART and Awaiting (AWTG) Contractor (CTR) Support. SHT PART is defined in the UM 4000–125 as:

> Short parts. Parts required to repair the item have been determined and are on requisition or being procured from other sources. Job is being held pending receipt of required parts. (GCSS-MC, 2020)

The code AWTG CTR Support is as its title suggests, the SR requires support from the contractor (in this case BAE) rather than internal unit maintenance personnel. The other notable job status codes include "Approved," meaning the initial request has been approved by the relevant equipment operator and forwarded to the supporting maintenance activity, and SHT FUND which indicates funding is not sufficient to obligate parts or labor to repairs. The full descriptions of other job status codes can be found in Appendix E.

The next part of this analysis was determining where these job statuses fall in terms of operational status of the systems. Tables 19–21 provide the breakdown of job statuses applied to each of the major operational statuses.

Table 19. 3d AABn Open SRs Maintaining Operational Status "Operational –Minor" by Job Status Occurrence

Job Status	Op Status Totals	%	Cumulative
AWTG CTR Support	**98**	**29.61%**	**29.61%**
SHT PART	**55**	**16.62%**	**46.22%**
SHT FUND	**45**	**13.60%**	**59.82%**
Approved	**42**	**12.69%**	**72.51%**
Planned	40	12.08%	84.59%
Waiting Approval	26	7.85%	92.45%
INS PRGS	7	2.11%	94.56%
SHT SPAC	6	1.81%	96.37%
SHT TECH	4	1.21%	97.58%
RPR PRGS	3	0.91%	98.49%
FINL INS	2	0.60%	99.09%
Assigned	1	0.30%	99.40%
INS COMP	1	0.30%	99.70%
Open	1	0.30%	100.00%

Table 20. 3d AABn Open SRs Maintaining Operational Status "Operational –Degraded" by Job Status Occurrence

Job Status	Op Status Totals	%	Cumulative %
SHT PART	**22**	**51.16%**	**51.16%**
Approved	8	18.60%	69.77%
SHT SPAC	4	9.30%	79.07%
SHT TECH	3	6.98%	86.05%
RPR PRGS	2	4.65%	90.70%
EQUIP ACCEPTED	1	2.33%	93.02%
INS PRGS	1	2.33%	95.35%
Planned	1	2.33%	97.67%
Waiting Approval	1	2.33%	100.00%

Table 21. 3d AABn Open SRs Maintaining Operational Status "Deadlined" by Job Status Occurrence

Job Status	Op Status Totals	%	Cumulative
Approved	**43**	**47.25%**	**47.25%**
SHT PART	**42**	**46.15%**	**93.41%**
Waiting Approval	4	4.40%	97.80%
INS PRGS	2	2.20%	100.00%

With these observations, examination was conducted into correlating problem codes under each operational status for the job statuses with the highest rates of use. AWTG CTR Support was found only with SRs maintaining "Operational–Minor" status, and even further only using the problem code NMAJ MODAP, indicating modifications made to the assigned ACV systems. The most significant observation of this data subset was the number of days these requests have remained open. Of the 98 SRs listed AWTG CTR Support, the newest request as of the reporting period was 68 days old, and the oldest being open for 606 days. The average across these requests was 212 days open. Another notable observation was the requests indicating SHT FUND. All of those requests dealt with SL-3 replenishment, with a "Days Open" median of 139, average of 210, and a minimum and maximum of 23 and 661 days, respectively. For both AWTG CTR Support and SHT FUND, every SR fell under the severity category "C-Routine."

Most requests with a job status of "Approved" were split between "Operational – Minor" status and "Deadlined," with only eight falling under "Operational – Degraded." As mentioned previously, "Approved" indicates the initial approval of a SR in the corrective maintenance process. Examining the assigned problem codes for the SRs with "Operational – Minor" status shows that 36 of 42 requests are NMAJ and related to SL-3 replenishment or replacement. The remaining six requests concern PMCS. The newest request at the end of the reporting period was 24 days old for a PMCS request and 54 for SL-3 replenishment. The median days open for these requests was 131 days, with an average of 180 due to the oldest request totaling 803 days open.

Requests with an "Approved" status were examined by problem codes under an "Operational – Degraded" status and "Deadlined" together. Table 22 shows this breakdown.

Table 22. 3d AABn Open SRs Maintaining Operational Status "Operational –Degraded" or "Deadlined" with "Approved" Job Status by Problem Code Occurrence

Problem Code	Job Status Total	%	Cumulative %
BODY	**13**	**25.49%**	**25.49%**
SUSP	**12**	**23.53%**	**49.02%**
COMP	8	15.69%	64.71%
HYDR	4	7.84%	72.55%
ELEC	3	5.88%	78.43%
FUEL	3	5.88%	84.31%
AIR	1	1.96%	86.27%
ARMT	1	1.96%	88.24%
AXLE	1	1.96%	90.20%
FCON	1	1.96%	92.16%
PWRT	1	1.96%	94.12%
STEERING	1	1.96%	96.08%

The body and suspension subsystems making up the majority of requests under this criterion are expected at this period. The significance of this observation comes with the associated timelines. Across all these specific requests, the most recent request has been open for 26 days at the end of the reporting period. The median days open was 110 days and the average 161 days, driven by an outlier request that has been open for 560 days identified with the problem and defective code ELEC INOP. Of the body and suspension problem codes, BODY had a median of 157 days open. The average was 202 days with a minimum value of 100 days and maximum of 385 days. The median for SUSP was 46.5 days open, with an average of 97.5 days, minimum of 26 days, and maximum of 333 days open. All of these SRs were categorized as "A-Critical" or "B-Urgent" in severity.

The final examination of this data was between SRs with a job status of "SHT PART" under operational status of "Operational–Degraded" or "Deadlined" and the problem codes associated. This relationship is depicted in Table 23.

Table 23. 3d AABn Open SRs Maintaining Operational Status "Operational –Degraded" or "Deadlined" with "SHT PART" Job Status by Problem Code Occurrence

Problem Code	Job Status Total	%	Cumulative %
SUSP	**23**	**35.94%**	**35.94%**
BODY	**13**	**20.31%**	**56.25%**
COMP	9	14.06%	70.31%
ELEC	4	6.25%	76.56%
HYDR	3	4.69%	81.25%
STEERING	3	4.69%	85.94%
COOL	2	3.13%	89.06%
ENG	2	3.13%	92.19%
FUEL	2	3.13%	95.31%
AIR	1	1.56%	96.88%
AXLE	1	1.56%	98.44%
PWRT	1	1.56%	100.00%

The suspension subsystem appears to not just be a common issue of the ACV system in 3d AABn, but also susceptible to part shortages that cause SRs to remain open for long periods of time. SRs with SHT PART job statuses held a median value of 144 days open and an average of 153 days. The most recent SR with this status during the reporting period was 24 days and the oldest 510 days. Among the SRs for just the suspension subsystem, the most recent was open 24 days and the oldest 262 days. All but one of the SRs maintaining operational status "Deadlined" were also categorized with the severity category "A-Critical," with the rest categorized as "B-Urgent."

4. Additional Observations

An examination of the serials associated with the open SR report revealed parallels with the closed report, most notably that a multitude of serials are affected and a lack of any concentration of SRs to one or a small population of systems. The open report has 144 unique serial identifiers belonging to 3d AABn across all 468 SRs. Of this, 91 systems report "Deadlined" and 42 "Operational–Degraded." This leaves a remarkable 11 ACV systems with open SRs that aren't significantly affected by their current maintenance issues.

An additional comparison was made between the systems that were previously "Deadlined" in the closed report and those maintaining the same operational status in the open report. Of the eight ACV systems that had previously closed SRs that were deadlined seven were again "Deadlined" in the open report. Serial 688793 previously had two "Deadlined" SRs in the closed report, both related to suspension issues. Serial 688799 had a repeat problem code of SUSP SEAL that had closed on the same day the open request was created, potentially implying an improperly closed request. It currently holds an "Approved" job status. Serial 688803 previously had a problem code of DAD1 that deadlined it in 2022 and its open SR indicated SUSP CBB as of July 2024, also currently in an "Approved" job status.

A final analysis was conducted on the second-largest unit included in the open SR report for comparison, the AAS in Camp Pendleton. AAS currently has 149 open SRs as of the end of the reporting period. Of these, 16 ACV systems (10.7%) are considered "Deadlined." An additional 19 systems (12.8%) maintain "Operational–Degraded" status. Seven of the 16 "Deadlined" systems have problem codes under the suspension subsystem, with the job status of five of them listed as SHT PART and one SHT FUND. The oldest of these has been open 161 days and the newest is 31 days. All of the "Deadlined" SRs for AAS are categorized with severity "A-Critical."

E. ACV STAFFING

The published TO&E structure for 3d AABn was reviewed to ensure the appropriate staffing billets are assigned to meet mission requirements. A Headquarters and Service Company, Alpha Company, Bravo Company and Charlie Company make up 3d AABn. The 3d AABn is a separate battalion organic to 1st Marine Division and "possess the assets to mechanize one infantry regiment or parts of multiple regiments" (TFSMS, 2024e).

1. Headquarters and Service Company

The Headquarters and Service Company is identified by the unit identification code (UIC) M21821 and contains the Battalion Headquarters, Communications Section, Medical Section, Religious Affairs Section, Motor Transport Section, Supply Section, Maintenance Platoon, General Support Platoon, Mobility-Counter Mobility Platoon, and Company Headquarters. The mission of the Headquarters and Service Company is specified on their mission statement in TFSMS as "to provide the Battalion Commander the means to train, maintain, prepare, and sustain subordinate units in order to support the ground combat element (GCE) with maneuver, fires, force protection, and command and control" (TFSMS, 2024d).

Of significant interest for this research is the mission and staffing of the maintenance platoon. Specified under Logistics Capabilities within TFSMS "the maintenance platoon provides field level organizational maintenance on all assigned organic equipment; limited field level intermediate maintenance provided as authorized. Provides organizational maintenance on all assigned equipment; limited intermediate level maintenance on all motor transport equipment; limited intermediate level maintenance on assigned infantry weapons; and intermediate level maintenance on the AAV" (TFSMS, 2024d). The maintenance platoon is structured for two officers and 51 enlisted Marines. The officers include a CWO4 MOS 2110 Platoon Commander/Battalion Maintenance Officer and CWO2 MOS 2120 Weapons Repair Officer. The enlisted Marines include a MGySgt MOS 2149 Maintenance Chief, MSgt MOS 2149 Assistant Maintenance Chief, one MOS 0411 Maintenance Management Specialist, two MOS 2141 Hazardous Materials/Waste Specialists, 19 MOS 2141 AAV Technicians, one MOS 1316 Metal Worker, two MOS 2161 Machinists, one MOS 1341 Engineer Equipment Mechanic, one MOS 1341 Engineer Equipment Repairer, one MOS 1164 Utilities Systems Technician NCO, one MOS 1345 Engineer Equipment Operator, four MOS 2171 Electro-optical Ordnance Repairers, and 16 MOS 2141 Amtrac Technicians (TFSMS, 2024d). Table 24 summarizes the staffing by MOS and quantity. Of note, the Headquarters and Service Company does not hold any E01577K/ACV-P on their table of equipment. All E01577K/ACV-P are held by Alpha, Bravo, and Charlie Company on their respective TO&E structure.

Table 24. Maintenance Platoon H&S CO 3D AA BN 1ST MARDIV

Billet Description	MOS	Quantity
Platoon Commander/Battalion Maintenance Officer	2110	1
Weapons Repair Officer	2120	1
Maintenance Chief	2149	1
Assistant Maintenance Chief	2149	1
Maintenance Management Specialist	0411	1
Hazardous Materials/Waste Specialist	2141	2
AAV Vehicle Technician	2141	19
Metal Worker	1316	1
Machinists	2161	2
Engineer Equipment Mechanic	1341	1
Engineer Equipment Repairer	1341	1
Utilities Systems Technician NCO	1164	1
Engineer Equipment Operator	1345	1
Electro-optical Ordnance Repairer	2171	4
Amtrac Technician	2141	16
	Total	53

2. Alpha Company

Alpha Company is identified by UIC M21822 and contains a Company Headquarters, Communications Section, Maintenance Section, Command and Control Section, and AA Platoons. The Maintenance Section is comprised of an MOS 2110 Ordinance Vehicle Maintenance Officer, an MOS 2149 Maintenance Chief, an MOS 2141 Assistant Maintenance Chief, nine MOS 2141 AAV Repairers, two MOS 1316 Metal Workers (TFSMS, 2024a). Alpha Company also contains three maintenance repair teams each identified to be staffed with five MOS 2141 AAV Repairers. Tables 25 through 28 summarize the staffing by MOS and quantity. Of note, Alpha Company holds 38 E01577K/ACV-P on their table of equipment (TFSMS, 2024a).

Table 25. Alpha CO 3D AA BN 1ST MARDIV

Nomenclature	TAMCN	T/E
Amphibious Combat Vehicle – 4335000	E01577K	38

Table 26. Maintenance Section Alpha CO 3D AA BN 1ST MARDIV

Billet Description	MOS	Quantity
Ordinance Vehicle Maintenance Officer	2110	1
Maintenance Chief	2149	1
Assistant Maintenance Chief	2141	1
AAV Repairer	2141	9
Metal Worker	1316	2
	Total	14

Table 27. Maintenance Repair Teams Alpha CO 3D AA BN 1ST MARDIV

AAV Repairer	2141	15
	Total	15

Table 28. Maintainer-to-Vehicle Ratio

Total Maintenance Staff	29
Total ACVs	38
Maintainer-to-vehicle ratio	1 : 1.31

3. Bravo Company

Bravo Company is identified by UIC M21823 and contains a Company Headquarters, Communications Section, Maintenance Section, Command and Control Section, and AA Platoons. Bravo Company's Maintenance Section is comprised of an MOS 2110 Ordinance Vehicle Maintenance Officer, an MOS 2149 Maintenance Chief, an MOS 2141 Assistant Maintenance Chief, 23 MOS 2141 AAV Repairers and one MOS 0411 Maintenance Management Specialist (TFSMS, 2024b). Of interest, Bravo Company consists of four maintenance repair teams, each containing five MOS 2141 AAV Repairers; however, the maintenance repair teams fall under the Maintenance Section on the Bravo Company Billet Organization, as opposed to a distinct separation between the sections seen on the Alpha Company Billet Organization. Tables 29 through 31 summarize the staffing by MOS and quantity. Of note, Bravo Company holds 57 E01577K/ACV-P on their table of equipment (TFSMS, 2024b).

Table 29. Bravo CO 3D AA BN 1ST MARDIV

Nomenclature	TAMCN	T/E
Amphibious Combat Vehicle – 4335000	E01577K	57

Table 30. Maintenance Section Alpha CO 3D AA BN 1ST MARDIV

Billet Description	MOS	Quantity
Ordinance Vehicle Maintenance Officer	2110	1
Maintenance Chief	2149	1
Assistant Maintenance Chief	2141	1
AAV Repairer	2141	23
Maintenance Management Specialist	0411	1
	Total	27

Table 31. Maintainer-to-Vehicle Ratio

Total Maintenance Staff	27
Total ACVs	57
Maintainer-to-vehicle ratio	1 : 2.11

4. Charlie Company

Charlie Company is identified by UIC M21827 and contains the same sections as Alpa and Bravo Company. The Maintenance Section is comprised of an MOS 2110 Platoon Commander/Company Maintenance Officer, an MOS 2149 Maintenance Chief, an MOS 2141 Assistant Maintenance Chief, and 23 MOS 2141 AAV Repairers and one MOS 0411 Maintenance Management Specialist (TSMS, 2024c). The Charlie Company Billet Organization is identical to Bravo Company besides the billet title of the Maintenance Officer. Similar to Bravo Company, the Charlie Company Maintenance Section contains four maintenance repair teams with five MOS 2141 AAV Repairers on each team. Tables 32 through 34 summarize the staffing by MOS and quantity. Of note, Charlie Company holds 76 E01577K/ACV-P on their table of equipment leading to a decreased maintainer-to-vehicle ratio of 1: 2.81 (TFSMS, 2024c).

Table 32. Charlie CO 3D AA BN 1ST MARDIV

Nomenclature	TAMCN	T/E
Amphibious Combat Vehicle – 4335000	E01577K	76

Table 33. Maintenance Section Alpha CO 3D AA BN 1ST MARDIV

Billet Description	MOS	Quantity
Platoon Commander/Company Maintenance Officer	2110	1
Maintenance Chief	2149	1
Assistant Maintenance Chief	2141	1
AAV Repairer	2141	23
Maintenance Management Specialist	0411	1
	Total	27

Table 34. Maintainer-to-Vehicle Ratio

Total Maintenance Staff	27
Total ACVs	76
Maintainer-to-vehicle ratio	1 : 2.81

F. AAV STAFFING

The published TO&E structure for 2d AABn was also reviewed for comparison to that of 3d AABn. The 2d AABn is comprised of a Headquarters and Service Company, Alpha Company, and Bravo Company. The 2d AABn is a separate battalion organic to 2nd Marine Division and "possess the assets to mechanize one infantry regiment or parts of multiple regiments" (TFSMS, 2023d).

1. Headquarters and Service Company

The 2d AABn Headquarters and Service Company is identified by the UIC M21811 and contains an identical organization and mission statement to that of 3d AABn Headquarters and Service Company. Within the Headquarters and Service Company is the Battalion Headquarters, Communications Section, Medical Section, Religious Affairs Section, Motor Transport Section, Supply Section, Maintenance Platoon, General Support Platoon, Mobility-Counter Mobility Platoon, and Company Headquarters. The mission of the Headquarters and Service Company is "to provide the Battalion Commander the means to train, maintain, prepare, and sustain subordinate units in order to support the GCE with maneuver, fires, force protection, and command and control" (TFSMS, 2023c).

Similarly to that of 3d AABn, the maintenance platoon is detailed under Headquarters and Service Company Logistics Capabilities within TFSMS. The mission statement is identical to 3d AABn where "the maintenance platoon provides field level organizational maintenance on all assigned organic equipment; limited field level intermediate maintenance provided as authorized. Provides organizational maintenance on all assigned equipment; limited intermediate level maintenance on all motor transport equipment; limited intermediate level maintenance on assigned infantry weapons; and intermediate level maintenance on the AAV" (TFSMS, 2023c).

The maintenance platoon is structured slightly different to that of 3d AABn with two officers and 46 enlisted Marines (five less enlisted Marines compared to 3d AABn). The officers include a CWO4 MOS 2110 Platoon Commander/Battalion Maintenance Officer and CWO2 MOS 2120 Weapons Repair Officer. The enlisted Marines include a MGySgt MOS 2149 Maintenance Chief, MSgt MOS 2149 Assistant Maintenance Chief, one MOS 0411 Maintenance Management Specialist, two MOS 2141 Hazardous Materials/Waste Specialists, 15 MOS 2141 AAV Technicians, one MOS 1316 Metal Worker, two MOS 2161 Machinists, one MOS 1341 Engineer Equipment Mechanic, one MOS 1341 Engineer Equipment Repairer, one MOS 1142 Electrical System Technician, one MOS 1345 Engineer Equipment Operator, three MOS 2171 Electro-optical Ordnance Repairers, and 16 MO

S 2141 Amtrac Technicians (TFSMS, 2023c). Table 35 summarizes the staffing by MOS and quantity.

Table 35. Maintenance Platoon H&S CO 2D AA BN 2D MARDIV

Billet Description	**MOS**	**Quantity**
Platoon Commander/Battalion Maintenance Officer	2110	1
Weapons Repair Officer	2120	1
Maintenance Chief	2149	1
Assistant Maintenance Chief	2149	1
Maintenance Management Specialist	0411	1
Hazardous Materials/Waste Specialist	2141	2

AAV Technician	2141	15
Metal Worker	1316	1
Machinists	2161	2
Engineer Equipment Mechanic	1341	1
Engineer Equipment Repairer	1341	1
Electrical System Technician	1142	1
Engineer Equipment Operator	1345	1
Electro-optical Ordnance Repairer	2171	3
Amtrac Technician	2141	16
	Total	48

The maintenance platoon staffing structure between the AAV and ACV based units are nearly identical, except the ACV based 3d AABn required additional personnel. Differences include an increase in four MOS 2141 AAV Technicians in 3d AABn, one additional MOS 2171 Electro-optical Ordnance Repairer in 3d AABn, and a swap of one MOS 1142 Electrical System Technician in 2d AABn for a MOS 1164 Utilities Systems Technician NCO in 3d AABn. Overall, the ACV-based maintenance platoon was staffed with five additional Marines or 10.4% more personnel (TFSMS, 2023c).

2. Alpha Company

Alpha Company, 2d AABn, is identified by UIC M21812 and structured identically to that of 3d AABn with a Company Headquarters, Communications Section, Maintenance Section, Command and Control Section, and AA Platoons. The Maintenance Section is arranged with the same quantity of maintenance personnel at the company, in comparison to that of the ACV based 3d AABn. The Maintenance Section is comprised of an MOS 2110 Ordinance Vehicle Maintenance Officer, an MOS 2149 Maintenance Chief, an MOS 2141 Assistant Maintenance Chief, 24 MOS 2141 AAV Repairers, one MOS 1316 Metal Worker, and one MOS 0411 Maintenance Management Specialist (TFSMS, 2023a). Eighteen of the MOS 2141 AAV Repairers are organized into three maintenance repair teams, each containing six Marines (as opposed to five seen in 3d AABn) (TFSMS, 2023a). Table 36 summarizes the staffing by MOS and quantity.

Table 36. Maintenance Section Alpha CO 2D AA BN 2D MARDIV

Billet Description	**MOS**	**Quantity**
Ordinance Vehicle Maintenance Officer	2110	1
Maintenance Chief	2149	1
Assistant Maintenance Chief	2141	1
AAV Repairer	2141	24
Metal Worker	1316	1
Maintenance Management Specialist	0411	1
	Total	29

3. Bravo Company

Bravo Company, 2d AABn, is identified by UIC M21813 and similarly contains a Company Headquarters, Communications Section, Maintenance Section, Command and Control Section, and AA Platoons. The maintenance section in Bravo Company is arranged identically to that of Alpha Company, 2d AABn, with 29 total Marines staffed as indicated in Table 37. As seen in Alpha Company, the AAV based maintenance section in Bravo company has the same staffing levels seen in the ACV based maintenance sections as well (TFSMS, 2023b).

Table 37. Maintenance Section Bravo CO 2D AA BN 2D MARDIV

Billet Description	**MOS**	**Quantity**
Ordinance Vehicle Maintenance Officer	2110	1
Maintenance Chief	2149	1
Assistant Maintenance Chief	2141	1
AAV Repairer	2141	24
Metal Worker	1316	1
Maintenance Management Specialist	0411	1
	Total	29

Overall, the assigned maintenance staff in 2d AABn is tremendously similar to that assigned to 3d AABn. The identical maintenance staffing levels between the battalions is commensurate with the one-for-one swap of ACV for AAV, independent of any adjustments to staffing levels that may be required in support of the new vehicle.

G. CAPABILITY DEVELOPMENT DOCUMENT

Multiple KPP threshold and development objectives established in the CDD for the ACV Phase 1, Increment 2 appeared to be inadequately upheld for the fielded ACV-P analyzed in this research. KPP's that failed to be maintained include attribute 5.1.1 "The ACV shall have a Materiel Availability of 75% defined as 'operations end items/total population'" and 5.1.2 "the ACV shall have an Operational Availability of 81%." Furthermore, multiple Additional Performance Attributes established in the CDD were inadequately upheld, including 5.3.28 "the ACV shall have a maximum time to repair of operational mission failures requiring field level (or below) maintenance of 8 clock-hours for 90% of all OMF [Organizational Maintenance Facility] repairs" and 5.3.30 "the ACV and ACV training systems shall be designed such that the time to train a single ACV operator or ACV maintainer is no longer than the equivalent AAV training course" (DoD, 2015).

1. 5.1.1 Materiel Availability

The low materiel availability of the ACV is noticeably linked to the supply and equipment management associated with ACV parts. According to the Program Manager, Advanced Amphibious Assault, the Marine Corps was "exhausting the part supply faster than we could replace" (Systems Command, 2024). The program continues to face challenges with an immature supply chain, obtaining technical data from the original equipment manufacturer (OEM), and transitioning parts to Defense Logistics Agency (DLA; Systems Command, 2024). The findings in this analysis concurs with the PM's assessment, particularly in relation to the suspension subsystem.

2. 5.1.2 Operational Availability

As addressed at the onset of this research, the operational availability of the ACV is critically below standards with fleet metrics sitting between 30% and 50%; however, the KPP developmental objective for operational availability was listed at 90% with a developmental threshold of 81% (DoD, 2015). In response to the challenges to operational availability, PM AAA stood up a readiness control board to conduct root causes analysis on the top 10 readiness drivers to quickly get solutions to the fleet to address the readiness impacts (Marine, 2024). In the course of this research, findings have shown a strong correlation between material availability and operational availability, reflecting the need to evaluate the current supply chain.

3. 5.3.28 Maximum Time to Repair

Appearing as an ambitious goal, the additional performance attribute limiting the maximum time to repair "operational mission failures requiring field level (or below) maintenance" is listed with a developmental objective of "four clock-hours for 90% of all OMF repairs" and a threshold objective of eight clock-hours (DoD, 2015). The problem with this attribute is that it is entirely negated by a struggling supply chain. Each maintenance action might be designed to be repaired in this limited time period, but the reality is that the majority of time a service request remains open is due to processes and factors outside of the repair itself, i.e., waiting for a part to be in stock.

4. 5.3.30 ACV Training

Counter to the original additional performance attribute 5.3.30 with an objective of reducing the time required to train a single ACV operator or ACV maintainer by 20% (DoD, 2015), the Operators New Equipment Training (OPNET) course was revised and expanded in length to address the unique challenges associated with the new platform (Systems Command, 2024). This also contradicts the DOTmLPF-P consideration in 12.3 that "training time must be no longer than the current time required to train an AAV marine" (Deputy Commandant, 2019).

H. LIFE CYCLE SUSTAINMENT PLAN

The LCSP utilized data collected during Reliability Growth Test (RGT), Reliability Qualification Testing (RQT), Operational Assessment (OA), and Initial Operational Test and Evaluation (IOT&E) as the basis of expectation for sustainment planning. RQT and IOT&E data was collected during LRIP for the ACV-P through October 2020 and presented in the LCSP under Sustainment Performance Results. Under Sustainment Operational Availability, RQT and IOT&E MCOTEA reported 80%, just under the 81% threshold (PEO LS, 2020). However, later IOT&E/DOT&E reported 91%, just above the objective of 90%. Sustainment Material Availability was reported very favorably, with RQT reporting 93% and IOT&E/DOT&E reporting 90%, both meeting the objective of 90% (PEO LS, 2020). No information on the testing was obtained as a part of this research but a review of both the current readiness reports and GCSS-MC data indicate a disconnect between the testing and evaluation of ACV sustainment and what is currently being experienced by fleet units as they transition to the ACV system.

Section 9 of the LCSP discusses Supportability Analyses. In Subsection 9.1.1: Failure Modes, Effects, and Criticality Analysis (FMECA), it is explicitly stated that the contractor (BAE) was not required to provide a FMECA on their NDIs (PEO LS, 2020). The ACV is considered a COTS/NDI item as the base design was developed from the Iveco SUPERAV. One of the NDIs of this system would include the H-Drive suspension subsystem that Iveco developed for their initial design.

I. CHAPTER SUMMARY

This chapter examined ACV GCSS-MC maintenance service requests in 3d AABn and analyzed the correlation between severity, problem code, and operational status. Additionally, unit maintenance staffing and structure of 3d AABn and 2d AABn were examined and compared. Last, KPPs and attributes from the CDD were discussed alongside observations from relevant sections of the LCSP. The next chapter details the summary of research findings, answers the original research questions, and provides areas for further research.

VI. SUMMARY, CONCLUSIONS, AND AREAS FOR FURTHER RESEARCH

This chapter presents the limitations experienced during the research, summary of findings, answers to original research questions, and suggestions for further research.

A. RESEARCH LIMITATIONS

The ACV is an ACAT 1C program with a vast amount of documentation, data, and personnel involved over a decade of acquisition effort. Tracing the exact genesis of any issue is difficult and one of the reasons MARCORSYSCOM reached out to NPS to help address it alongside numerous parallel efforts from different parts of the program and fleet commands.

The largest limitation of this research was the acquisition of documents and data needed to draw significant conclusions to the research questions posed. Sources that could not be obtained publicly required a third-party representative with access to Marine Corps Enterprise Systems to provide the information that was analyzed.

Limitations in scope were also required to keep research focused and findings viable. Using existing maintenance records from the primary enterprise system used to log service requests kept data collection at the unit level and permitted parity with the staffing analysis as well as the intended program objectives outlined in the CDD and LCSP. Comparisons to other systems were minimized in both analysis and literature review to ensure the dissipation of noise and limit data saturation.

B. SUMMARY OF FINDINGS

Analysis of multiple GCSS-MC reports demonstrated evidence to reinforce claims of supply chain struggles and early adoption issues of the ACV. The chief findings showed substantial recurring issues within the ACV’s suspension system, an NDI from Iveco’s SuperAV 8x8 design. These issues are compounded by a continuous shortage of parts across multiple subsystems and corresponding service requests taking months to resolve as opposed to days or even weeks.

Staffing analysis demonstrated the limited differences between units fielded with legacy AAV and those fielding the ACV. The largest change is in the number of vehicles each unit is responsible for and fields down to the platoon level. Despite this, the GCSS-MC data analysis did not reveal significant issues regarding manpower shortages to complete service requests. This aligns with the lack of overall readiness improvement despite some increases in personnel to combat growing problems.

Analysis of the CDD and LCSP show that the current state of the ACV demonstrates a failure of at least two KPPs relating to sustainment and struggles in other attributes included in the desires for a worthwhile replacement of the AAV. Levels of sustainment reported in testing are disconnected from the current reality of ACV readiness, and the COTS/NDI nature of the ACV may have had an effect on early identification of design limitations and potential issues.

C. REVIEW OF RESEARCH QUESTIONS

(1) What steps could be taken at the unit, organization, and program management levels to improve the overall readiness of Assault Amphibious Battalions currently equipped with the ACV as well as units undergoing transition to the ACV from the AAV?

At the unit level, it is imperative that data entered into GCSS-MC for the purpose of initiation of maintenance actions and tracking be as accurate and up to date as possible. Periodic audits of service requests are critical to identifying and investigating issues that remain open for unacceptable amounts of time. This point leads into another recommendation, that being the mandatory reporting forward of systems remaining "Deadlined" for extended periods. Readiness metrics are regularly pushed up the chain of command and individual serial numbers of deadlined systems should as well, with their corresponding GCSS-MC reports. This could potentially provide higher commanders a better understanding of the maintenance issues at the lowest levels and facilitate more understanding and cross communication with the ACV program office. This may also incentivize local command procedures or policies that may ease some of the challenges of low readiness by actively preventing unplanned maintenance through changes in utilization or operational planning.

From the organizational level, research demonstrated that a change to TO&E in just personnel has not and will not resolve current issues. Supply chain difficulties permeate the current adoption of the ACV in 3d AABn and will likely continue as other fleet units receive them and its variants unless significant action is taken. One consideration would be a TO&E change to lower the number of vehicles allotted. This would have a far-reaching impact on the service, as the current allotment fulfills the capability of an AA platoon to mechanize a full Marine infantry company, as outlined in the CDD. Consideration should be given to current and planned tactics regarding Force Design, and whether transporting an infantry company purely by ACVs is not just necessary, but even viable on the next battlefield.

The program level has and will continue to bear the brunt solving these issues. The strongest recommendation that can be made on the basis of the analysis conducted is that an independent readiness review be conducted on a similar basis to those done for the Marine Corps' aviation platforms. A comprehensive report now by an independent agency like LMI has the potential to rectify issues early in the program's life cycle prior to the fielding of the ACV and its newer variants to the rest of the AABns. Separately, or perhaps in conjunction with the review, an evaluation of the suspension system design should be considered, to include additional OT&E with the fielding of the ACV-30 and ACV-R in mind. Last, contracts for sustainment and support should be reviewed and evaluated to verify if supply requirements are being met from the contractor alongside a process analysis of the current part procurement process.

(2) What can be learned from the maintenance model of similar systems?

An adaptive and flexible approach must be taken in the structure, staffing, and support of maintenance sections. It's been demonstrated, in cases such as the MV-22, that the existing force structure is not always sufficient to support a brand-new system. It is fundamentally inaccurate to classify the ACV as simply an upgrade of the AAV. It can perform similar mission functions but as a system the force and support structure surrounding it should be tailored to its specific needs. As inherently new challenges arise while fielding the ACV to AABns, Marine Corps planners and manpower management must remain flexible and willing to modify the traditional staffing structures used to sustain the AAV.

(3) What implications will any potential findings have for the introduction of new replacement systems?

A thorough understanding of military systems and the support structure required to sustain them should be understood before the systems are fielded. Struggles with logistics chains have consistently existed for nearly every major system in the Marine Corps and these issues will be compounded in the shift toward future amphibious operations like EABO and the implementation of the Littoral Combat Regiment. Major capability acquisition of a fundamentally COTS/NDI item should receive the same if not higher level of scrutiny that items developed organically. The benefits of a more rapid acquisition and existing support base from the contractor become short-term as modifications are made to meet warfighter specific needs and the operational tempo of the fleet inevitably takes the original design beyond its intended limits.

This case also highlights the danger of artificially imposed limitations of new systems. The ACV is a new infantry transport vehicle system that is being fitted into an existing force structure that was designed during the Cold War. Rather than considering what new capability can this system provide, the acquisition process sought to ensure the new system could provide the old capability.

D. SUGGESTIONS FOR FURTHER RESEARCH

Additional research on this subject would largely consist of access to documentation and data that was unobtainable during this period. A trace analysis of parts contracts could potentially uncover specific reasonings for part shortages and supply chain issues leading to long service request resolution times. This would also include insight into the development of the ACV by BAE using Iveco's design and the history between the two companies.

Splitting off from the ACV itself would be an analysis of GCSS-MC and its utility for maintenance among the major systems that mandate its use. Comparison with systems such as NALCOMIS for aviation units could provide areas of improvement to ensure accuracy and more effective tracking of parts and labor.

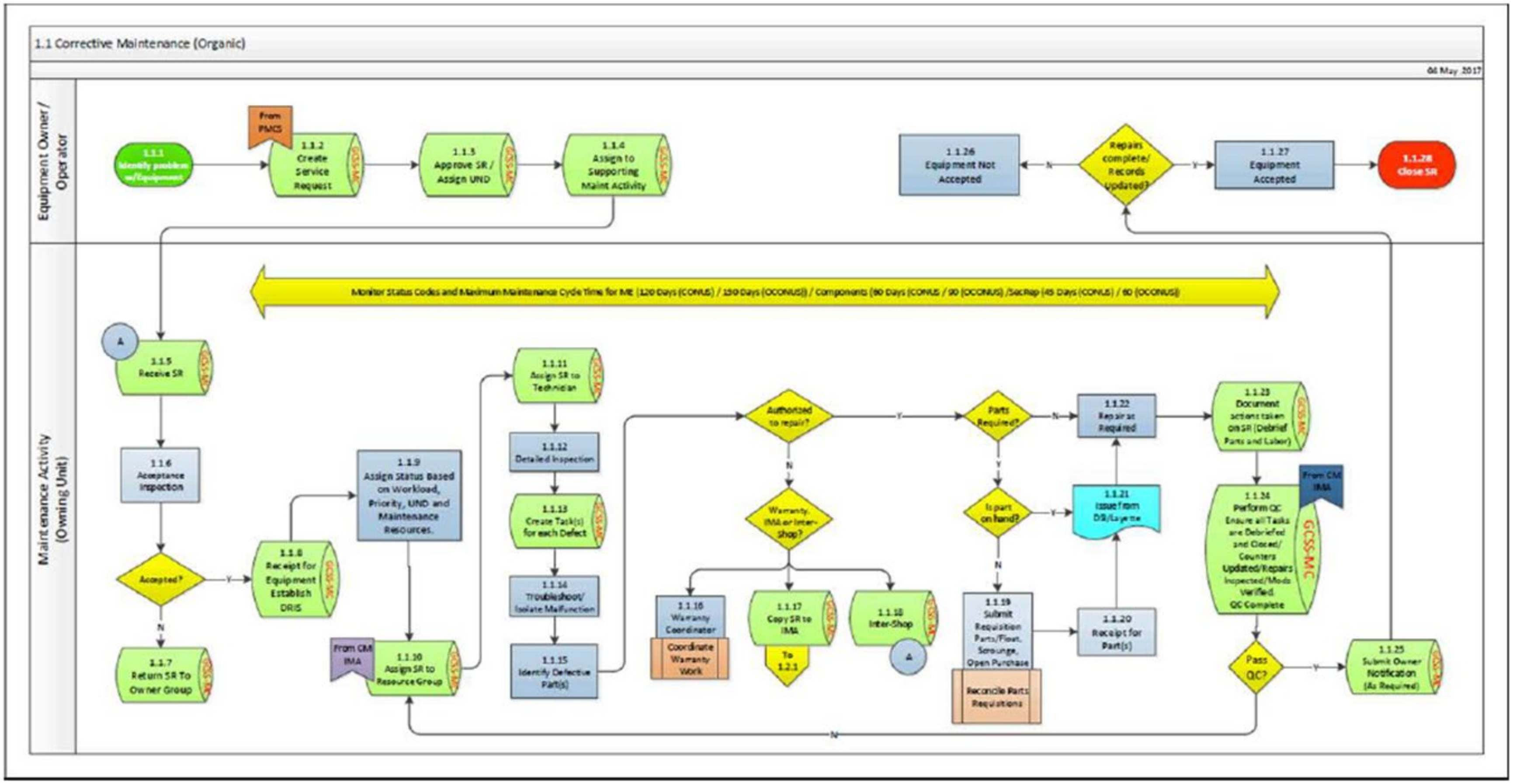
APPENDIX A. GCSS-MC REPORT SAMPLE

Operational Status	Service Request	Job Status	Days in Status	TAMCN	ID	Model	NIIN	Nomenclature	Serial Number	EQUIP Owner	MARES Category	Severity	Problem Code	SR Owner	Summary	Last Updated	Days Since Last Modified	DDL	DCD	DRIS	Creation Date	DIS	Days Open (CWT)	RDD	Days Late	Contact Name	AAC	Open Closed Status	Unit Name	Owner Group
Deadlined	34899064	SHT PART	7	E01577K	131 33A	4335000	16690331	AMPHIBIOUS COMBAT V	688792	UIC-M21820	MARES ME	03 A-Critical	AIR IN OP		Faulty CTIS Manifold	8/7/2024 8:14	0	131	8/7/2024 5:14	12/14/2023 0:36	12/14/2023 0:35	238	238			[redacted]	M21820	OPEN	M21820 3D AA BN 1ST MARDIV	AAC-M21820_CO_B_2ND
Operational - Degraded	34823442	RPR PRGS	2	E01577K	131 33A	4335000	16690331	AMPHIBIOUS COMBAT V	688788	UIC-M21820	MARES ME	06 B-Urgent	ELEC IN OP	[redacted]	DCP Does Not Dispaly	8/7/2024 8:11	0	125		12/13/2023 2:48	11/21/2023 2:15	239	261			[redacted]	M21820	OPEN	M21820 3D AA BN 1ST MARDIV	AAC-M21820_CO_B_2ND
Operational - Degraded	34897602	RPR PRGS	8	E01577K	131 33A	4335000	16690331	AMPHIBIOUS COMBAT V	688790	UIC-M21820	MARES ME	06 B-Urgent	ELEC CBB		AFES Harness Corroded	8/7/2024 7:54	0	204		12/13/2023 21:38	12/13/2023 21:36	238	238			[redacted]	M21820	OPEN	M21820 3D AA BN 1ST MARDIV	AAC-M21820_CO_B_2ND
Deadlined	35229556	RPR PRGS	8	E01577K	131 33A	4335000	16690331	AMPHIBIOUS COMBAT V	688848	UIC-M21820	MARES ME	03 A-Critical	BODY CBB		P2 Gearbox Class 3 Leak	8/7/2024 5:43	0	35	7/27/2024 4:50	3/25/2024 20:00	3/25/2024 20:00	135	135			[redacted]	M21820	OPEN	M21820 3D AA BN 1ST MARDIV	AAC-M21820_CO_B_2ND
Deadlined	35472288	SHT PART	58	E01577K	131 33A	4335000	16690331	AMPHIBIOUS COMBAT V	688847	UIC-MS3800	MARES ME	03 A-Critical	SUSP CBB	[redacted]	P4 SHOCK	8/7/2024 3:18	0	1	8/7/2024 0:18	5/31/2024 22:34	5/31/2024 22:32	68	68			[redacted]	M33800	OPEN	MS3800 ASLT AMPHIB SCOL BN	M33800-TVM-7
Deadlined	35517986	Waiting Approval	1	E01577K	131 33A	4335000	16690331	AMPHIBIOUS COMBAT V	688845	UIC-MS3800	MARES ME	03 A-Critical	SUSP CBB	[redacted]	P3 SHOCK	8/7/2024 2:53	1	9	7/29/2024 15:44	6/13/2024 23:44	6/13/2024 23:39	55	55			[redacted]	M33800	OPEN	MS3800 ASLT AMPHIB SCOL BN	M33800-TVM-7
Deadlined	35550630	SHT FUND	8	E01577K	131 33A	4335000	16690331	AMPHIBIOUS COMBAT V	688839	UIC-MS3800	MARES ME	03 A-Critical	HYDR CBB	[redacted]	POWER STEERING PUMP	8/7/2024 2:25	1	10	8/6/2024 23:25	6/27/2024 0:54	6/27/2024 0:53	42	42			[redacted]	M33800	OPEN	MS3800 ASLT AMPHIB SCOL BN	M33800-TVM-7
Deadlined	35627992	Waiting Approval	1	E01577K	131 33A	4335000	16690331	AMPHIBIOUS COMBAT V	688710	UIC-MS3800	MARES ME	03 A-Critical	ELEC IN OP		PNEUMATIC WIRING HARNESS INOP (3W0132-2)	8/7/2024 2:22	1	6	8/1/2024 18:40	7/23/2024 3:31	7/23/2024 3:31	15	15			[redacted]	M33800	OPEN	MS3800 ASLT AMPHIB SCOL BN	M33800-TVM-3
Deadlined	35540970	SHT TECH	12	E01577K	131 33A	4335000	16690331	AMPHIBIOUS COMBAT V	688748	UIC-M21820	MARES ME	03 A-Critical	HYDR PUMP		#3 HYDRO PUMP	8/7/2024 2:13	1	44	8/6/2024 23:13	6/25/2024 2:04	6/25/2024 2:00	44	44			[redacted]	M21820	OPEN	M21820 3D AA BN 1ST MARDIV	AAC-M21820_CO_A_3RD
Operational - Degraded	35548664	RPR PRGS	1	E01577K	131 33A	4335000	16690331	AMPHIBIOUS COMBAT V	688755	UIC-M21820	MARES ME	06 B-Urgent	SUSP SEAL		P2 and P3 HUB LEAK	8/7/2024 1:25	1	41		6/26/2024 20:20	6/26/2024 20:16	42	42			[redacted]	M21820	OPEN	M21820 3D AA BN 1ST MARDIV	AAC-M21820_CO_A_3RD
Supply or Service	35680278	Waiting Approval	1	E01577K	131 33A	4335000	16690331	AMPHIBIOUS COMBAT V	688706	UIC-MS3800	MARES ME	13 C-Routine	NMAJ SL3AP		SL3 REPLENISHMENT	8/7/2024 0:32	1			8/7/2024 0:15	8/7/2024 0:15	1	1			[redacted]	M33800	OPEN	MS3800 ASLT AMPHIB SCOL BN	M33800-TEAM1
Operational - Degraded	35298260	INS PRGS	6	E01577K	131 33A	4335000	16690331	AMPHIBIOUS COMBAT V	689154	UIC-M21820	MARES ME	06 B-Urgent	SUSP COTO		T/S Overpressure	8/7/2024 0:17	1			4/13/2024 0:12	4/13/2024 0:09	117	117			[redacted]	M21820	OPEN	M21820 3D AA BN 1ST MARDIV	AAC-M21820_CO_A_1ST
Operational - Degraded	35577944	SHT PART	20	E01577K	131 33A	4335000	16690331	AMPHIBIOUS COMBAT V	689165	UIC-M21820	MARES ME	06 B-Urgent	BODY MINR	[redacted]	RPL CREW SHOULDER SEAT BEALTS	8/7/2024 0:13	1			7/9/2024 0:44	7/9/2024 0:44	30	30			[redacted]	M21820	OPEN	M21820 3D AA BN 1ST MARDIV	AAC-M21820_CO_A_MAINT
Supply or Service	35295750	Approved	117	E00107K	132 27A	4370000	16803562	COMBAT VEHICLE, AMPH		AAC-M98808	MARES ME	13 C-Routine		[redacted]	Fielding resistribution	8/6/2024 23:28	1				4/12/2024 16:15		117			[redacted]	M98808	OPEN	AAC-M98808	AAC-M98808_P204
Operational - Minor	35356048	Planned	98	E01577K	131 33A	4335000	16690331	AMPHIBIOUS COMBAT V	688755	UIC-M21820	MARES ME	13 C-Routine	PMCS SAPM	[redacted]	Semi Annual PMCS	8/6/2024 20:22	1			4/30/2024 2:34	4/30/2024 2:34	100	100			[redacted]	M21820	OPEN	M21820 3D AA BN 1ST MARDIV	AAC-M21820_CO_A_3RD
Operational - Minor	35616238	SHT SPAC	7	E01577K	131 33A	4335000	16690331	AMPHIBIOUS COMBAT V	688792	UIC-M21820	MARES ME	13 C-Routine	NMAJ ASPM		Annual PMCS	8/6/2024 18:48	1			7/18/2024 19:10	7/18/2024 19:09	20	20			[redacted]	M21820	OPEN	M21820 3D AA BN 1ST MARDIV	AAC-M21820_CO_B_2ND

Adapted from GCSS-MC (2020).

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX B. GCSS-MC SERVICE REQUEST PROCESS MAP



Source: GCSS-MC (2020).

THIS PAGE INTENTIONALLY LEFT BLANK

VII. APPENDIX C. GCSS-MC PRIORITY DESIGNATOR (SEVERITY) CODES

This code is found in the following systems: GCSS-MC, ICP

Purpose/Use: The priority designator (PD) is located in rp 60-61 of requisitions, and related transactions, and is based upon a combination of factors that relate the relative importance of the requisitioner's mission, expressed by its Force or Activity Designator (F/AD), and the urgency of need of the end use expressed by the Urgency of Need Designator (UND). The F/AD (a Roman numeral) is assigned by the Secretary of Defense, the Chairman of the Joint Chiefs of Staff (CJCS), or a DoD Component authorized by the CJCS to assign F/ADs for their respective forces, activities, programs or projects. The criteria for assignment of an appropriate F/AD is in DoD 4140.1-R (DoD Materiel Management Regulation), Appendix I. The UND (an alphabetic character) is determined by the requisitioning activity. The criteria for assignment of the UND are below.

Derivation Of Priority Designators (Relating F/AD to UND)			
FORCE OR ACTIVITY DESIGNATOR	**URGENCY OF NEED**		
	A CRITICAL	**B** **URGENT**	**C** **ROUTINE**
I	01	04	11
II	02	05	12
III	03	06	13
IV	07	09	14
V	08	10	15

GCSS-MC presents priority options based on the unit's FAD. As the user prioritized SR and tasks the priority is perpetuated to material requisitions of the SR and/or task. For more information on priority designators, FAD, and UND relationships see Appendix 2.14 of DoD 4000.25-1-M or MCO 4400.16.

Definitions and requirements for each priority:

PD	**FAD/UND**	**EXPLANATION**
01	FAD I/UND A	CRITICAL: Required for an organization in combat. Key item without which the organization CANNOT perform its mission. Requires round-the-clock supply action on 7-day-week basis. Issue performance standard is 24 hours. Requires premium transportation. Fastest means of communication is authorized.
02	FAD II/UND A	CRITICAL: Required for FMF overseas and FMF CONUS force being maintained in a state of combat readiness for immediate (within 24 hours) employment or deployment. Key item without which the organization cannot perform its mission. Requires round-the-clock supply action on 7-day-week basis. Issue performance standard is 24 hours. Requires premium transportation. Fastest means of communication is authorized.
03	FAD III/UND A	CRITICAL: Required by FMF in and outside CONUS, not included under FAD II. Key item without which the organization CANNOT perform its mission. Requires round-the-clock supply action on 7-day-week basis. Issue performance standard is 24 hours. Requires premium transportation. Fastest means of communication is authorized.
04	FAD I/UND B	URGENT: Required for organization in combat; a key item, the lack of which impairs performance of mission. Requires premium transportation. Fastest means of communication is authorized.

05	FAD II/UND B	URGENT: Required for FMF overseas; an essential item, the lack of which impairs operational capability (combat readiness). Premium transportation normally required. Fastest means of communication is authorized.
06	FAD III/UND B	URGENT: An essential item, the lack of which impairs operational capability (combat readiness). Premium transportation normally required for FMF in and outside CONUS, not included under FAD II. Fastest means of communication authorized.
07	FAD IV/UND A	CRITICAL: Required for FMF supporting establishment or 4th Marine Division/Wing units; an essential item, the lack of which the organization cannot perform its mission. Premium transportation normally required. Fastest means of communication authorized.
08	FAD V/UND A	CRITICAL: Required for MARFORRES organization other than the 4th Marine Division/Wing units; a key item without which the organization cannot perform its mission. Premium transportation normally required. Fastest mean of communication authorized.
09	FAD IV/UND B	URGENT: Required for FMF supporting establishment or 4th Marine Division/Wing units; a key item, the lack of which impairs performance of mission. Normal communications.
10	FAD V/UND B	URGENT: Required for MARFORRES organizations other than the 4th Marine Division/Wing units; a key item, the lack of which impairs performance of mission. Normal communications.
11	FAD I/UND C	ROUTINE: Stock replenishment for organizations in combat. Most requisitions for organizations in combat should fall into this priority. Service units have a performance standard of 12 days from date of receipt to date of turning shipment over to carrier. Routine transportation and communication.
12	FAD II/UND C	ROUTINE: Stock replenishment for FMF overseas. Most requisitions for FMF overseas should fall into this class. Service unit have a performance standard of 12 days from date of receipt to date of turning shipment over to carrier. Routine transportation and communication.
13	FAD III/UND C	ROUTINE: Stock replenishment for FMF in and outside CONUS not included under FAD II. Most requisitions for FMF in CONUS should fall into this priority. Service units have a performance standard of 12 days from date of receipt to date of turning shipment over to carrier. Routine transportation and communication.
14	FAD IV/UND C	ROUTINE: Stock replenishment for FMF supporting establishment or 4th Marine Division/Wing units. Most requisitions for these organizations should fall into this priority. Routine transportation and communication.
15	FAD V/UND C	ROUTINE: Stock replenishment for MARFORRES other than 4th Marine Division/Wing units and organizations with FAD V. Most requisitions for these organizations should fall into this priority. Routine transportation and communication.

Source: GCSS-MC (2020).

APPENDIX D. GCSS-MC MAINTENANCE PROBLEM CODES

Also referred to as "Defect Codes" as found in the UM 4790-5

Found in GCSS-MC

Purpose/Use: Abbreviates and categorizes the primary maintenance problem of the item.

CODE	DESCRIPTION
A/C	Air Conditioners
AIR	Air System
ANEW	Ancillary Equipment/Wiring
ANTL	Antenna/Transmission line
ARMT	Armament
AXLE	Axle System
BODY	Body, Frame or Hull
CANV	Canvas
COMP	Component
COOL	Cooling System
DAD1	Data/Digital Systems
ELEC	Electrical System
ENG	Engine
FCON	Fire Control System
FUEL	Fuel System
HYDR	Hydraulic System
IGNI	Ignition System
LIFT	Boom, Cable and Lift System
LVTP	Landing Vehicle, Tracked, Personnel
MODM	Multiplex/Modulation-Demodulation
MTR	Meter
NMAJ	No Major Defect
PMCS	Preventive Maintenance Checks and Services
PWRP	Power Pack
PWRT	Power Train
RCIC	Receiver/Input Circuitry
STEERING	Steering Components and Hardware
SUSP	Suspension System
TEDD	Test Equipment/Display devices
TEXT	Textiles
TRAC	Track Crawler System
TRAN	Transmission
TROB	Tie Rod
TURR	Turret System
WPNS	Weapons/Small Arms/Crew served
XMOC	Transmitter/Output Circuitry

Found in GCSS-MC

Purpose/Use: Supplement the primary problem code, also known as Defective Code (Secondary), with additional an additional problem type which is an abbreviated category of secondary issues. This list of values is found in the cell to the right of the problem code.

CODE	**DESCRIPTION**
ACDCS	ACDCS Alternating Current/Direct Current Source
ADJS	Subassembly Adjustment
ADJUS	Adjust
ALGEN	Alternator, Generator Mechanism
ALGN	ALGN system Alignment
ARCB	Arcing/Burnt Components
ARMT	Armament
ASPM	Annual Scheduled Preventive Maintenance (once a year)
AUX	Auxiliary
BSPMM	Biennial Scheduled Preventive Maintenance (every two years)
BRK	Brake Systems and Components
BTRY	Battery
CABL	Cabling Malfunction
CANV	Canvas
CARB	Carburation System
CARR	Carriage and Mount Mechanism
CBB	Cracked, Broken or Bent
CONT	Control Mechanisms
CONV	Clutch, Convertor and Couplings
CORR	Corroded/Rusted
COTO	Components out of Tolerance
CYL	Cylinders, Accumulators and Replenishes
DIST	Distribution Systems
ELTR	Elevation and Traversing Mechanisms
EXSYS	Exhaust System
FAB	Fabrication or manufacture
FREQ	Frequency Shift/Stability
GLASS	Glass Replacement
GRND	Grounded
GUN	Gun Tube, Breach and Firing Mechanisms
HOSE	Hose, Tube and Fittings
HOUS	Housing and Castings
HRS	Hours (used with PMCS primary problem code)
HVPS	High Voltage Power Supply
HVSWR	High Voltage Standing Wave Radio
HYDR	Hydraulic System
INJEC	Injector System
INOP	Inoperative
LKPM	Lack of Preventive Maintenance
LPO	Low Power Out
LVPS	Low Voltage Power Supply

-Gamma	
SAFDL	Safety Deadline
SAPM	Semiannual Scheduled Preventive Maintenance (every 6 months)
SEAL	Packing, Seals and Gaskets
SEW	Sewing Rips/Torn Areas
SHORT	Shorted/Low Resistive Circuitry
SL3AP	SL-3 Application
SPRG	Springs, Shocks and Stabilizer Components
START	Starter
STEER	Steering Components
TORQ	Torque, Sprocket or Drive Mechanism
TORS	Torsion Components
UNAUT	Abuse/Unauthorized Maintenance
UNK	Unknown
VALV	Valves and Valve Components

Source: GCSS-MC (2020).

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX E. RELEVANT GCSS-MC JOB STATUS CODES

TYPE/ USE	CODE	DESCRIPTION
Maintenance	AWTG CTR Support	Awaiting CTR support. Equipment is awaiting contractor technical support. (i.e. Oshkosh, Harris)
Maintenance	AWTG Contact Team	Awaiting contact team support. Equipment is awaiting contact team support from higher or supporting level of maintenance (LOM)
Maintenance	Approval Required	Service Request requires authorized approval. (i.e. Urgency of Need authorization)
Maintenance	Approved	Service Request has been approved.
Maintenance	Assigned	Service Request has been assigned to an individual for repairs.
Maintenance	FINL INS	Final inspection. Job is undergoing final inspection upon completion of all repairs and equipment records are being completed.

TYPE/ USE	CODE	DESCRIPTION
Maintenance	Equip ACCEPTED	Equipment accepted. Starts the Date Received Into Shop (DRIS). This job status does not indicate the acceptance phase. This status indicates when the equipment has been inducted into the shop conducting the repairs thereby starting the DRIS. (Starting the DRIS on the acceptance date and not the inducted date will skew the 5 day timeline for IMA to conduct a detailed inspection of known faulty components and place parts on order.)
Maintenance	INS COMP	Inspection is completed. Final inspection is complete. All repairs and equipment records are completed.
Maintenance	INS PRGS	Inspection in progress. Job is undergoing inspection to determine extent of repairs and or parts required. Can be utilized during the acceptance, induction and active phases of maintenance.

TYPE/ USE	CODE	DESCRIPTION
Maintenance	ITRS REP	Intershop repair. This code will be used when an intershop SR is used.
ALL	Open	Default Job Status upon opening a SR. A job status change is required. Reflects that a Service Request has been initiated by the owning/requesting organization.
Maintenance	Planned	Service Request has been initiated for the purpose of scheduled maintenance.
Maintenance	RPR PRGS	Repair is in progress. This code indicates the job is actually being worked on in the shop or that other action is in progress.
ALL	Waiting Approval	Service Request is awaiting approval of a parts requirement from a supporting part approver.

TYPE/ USE	CODE	DESCRIPTION
Logistics	Response Provided	Not used for maintenance type SR. May be used by other logistics support activities.
Maintenance	SHT FUND	Short funds. This code will be used when, due to a shortage of funds, repair parts or labor costs cannot be obligated to complete repairs.
Maintenance	SHT PART	Short parts. Parts required to repair the item have been determined and are on requisition or being procured from other sources. Job is being held pending receipt of required parts.
Maintenance	SHT SPAC	Short space. Job is pending scheduling into shop for repair. This code indicates that no parts are required or that all required parts have been received but repairs have not begun due to the shortage of working space (bay, bench space, etc.).
Maintenance	SHT TECH	This code will be used when, due to a shortage of technicians (mechanics), the nature of repairs required has not been determined; or repairs required have not been determined; or repairs required have been determined, but trained personnel are not available to complete the work.

Source: GCSS-MC (2020).

LIST OF REFERENCES

Athey, P. (2020, November 10). *Marine Corps receives first amphibious combat vehicle*. *Marine Corps Times*. https://www.marinecorpstimes.com/news/marine-corps-times/2020/11/10/marine-corps-receives-first-amphibious-combat-vehicle/

BAE Systems. (2018, September). *Amphibious combat vehicle*. https://www.baesystems.com/en-us/product/amphibious-combat-vehicle

Berger, D. H. (2023, March 28). Statement of General David H. Berger Commandant of the Marine Corps on the posture of the United States Marine Corps before the Senate Appropriations Committee. United States Marine Corps. https://www.cmc.marines.mil/Speeches-and-Transcripts/Transcripts/Article/3360019/statement-of-general-david-h-berger-commandant-of-themarine-corps-on-the-postu/

Blanchard, B. S. (2004). *Logistics engineering and management* (6th ed.). Pearson.

Burgess, R. R. (2022, May 9). Marine Corps force design update adjusts MV-22 squadron force levels. *Seapower*. https://seapowermagazine.org/marine-corps-force-design-update-adjusts-mv-22-squadron-force-levels/

Busby, S. (2024, February 25). Groupthink gives V-22 a bad rap. *Defense One*. https://www.defenseone.com/ideas/2024/02/groupthink-gives-v-22-bad-rap/394420/

CE Noticias Financieras. [Translated by Content Engine, L. L. C.] (2023, Dec 12). *U.S. Marines buy new amphibious combat vehicle (ACV) units wanted by Spanish Navy*. CE Noticias Financieras. https://libproxy.nps.edu/login?url=https://www.proquest.com/wire-feeds/u-s-marines-buy-new-amphibious-combat-vehicle-acv/docview/2901387197/se-2

Flying leatherneck aviation museum. (2024). CH-46 Sea Knight. https://www.flyingleathernecks.org/aircraft-collection/ch-46-sea-knight

Davis, J. M. (2024, May 15). *V-22 woes: lessons learned from the harrier experience*. National defense magazine. https://www.nationaldefensemagazine.org/articles/2024/5/14/viewpoint-v22-woes-lessons-learned-from-the-harrier-experience

Department of Defense. (1998). *Electronic reliability design (MIL-HDBK-338B)* [Handbook].

Department of Defense. (2015). *Operation of the defense acquisition system (DoD Instruction 5000.02)*.

Department of Defense. (2021, November 4). *Product support management for the adaptive acquisition framework (DoDI 5000.91)*.

Deputy Commandant, Combat Development & Integration, USMC. (2019). *Capability development document for the amphibious combat vehicle phase 1, increment 2 (ACV 1.2) family of vehicles (FOV) and mission role variants (MRV): version 2.0 (MROC-Approved)*.

Director Operational Test and Evaluation. (2015). *Global combat support system – Marine Corps (GCSS-MC)*. https://www.dote.osd.mil/Portals/97/pub/reports/FY2015/navy/2015gcss-mc.pdf?ver=2019-08-22-105642-177

Doubleday, J. (2016, August 26). *Marine Corps plans MV-22 configuration overhaul to improve readiness*. Inside defense. https://insidedefense.com/daily-news/marine-corps-plans-mv-22-configuration-overhaul-improve-readiness

Eckstein, M. (2015, September 28). *Marine ACV competitors show off prototypes as program downselect nears*. USNI News. https://news.usni.org/2015/09/28/marine-acv-competitors-show-off-prototypes-as-program-downselect-nears

Fandom, Inc. (n.d.). *Boeing Vertol CH-46 Sea Knight*. Military Wiki. https://military-history.fandom.com/wiki/Boeing_Vertol_CH-46_Sea_Knight

GCSS-MC. (2020, January 6) GCSS-MC User Manual 4000–125. https://gcssmc-trng.gcds.disa.mil/um_4000.htm

Government Accountability Office. (2018, April 17). *Amphibious combat vehicle: program should take steps to ensure manufacturing readiness*. https://www.gao.gov/assets/gao-18-364.pdf

Irwin, S. I. (2016, April 25). *Marine Corps soon to complete probe of V-22 fleet readiness (updated)*. National defense magazine. https://www.nationaldefensemagazine.org/articles/2016/4/25/marine-corps-soon-to-complete-probe-of-v22-fleet-readiness-updated

Iveco Defence Vehicles. (n.d.). SUPERAV-Amphibious armored vehicle 8X8. https://www.idvgroup.com/products/armoured-vehicles/superav-amphibious-armoured-vehicle-8x8/

Joint Requirements Oversight Committee (JROC). (2011). *Initial capabilities document (ICD) for amphibious combat vehicle (ACV)*.

Knickerbocker, B. J. (2017). *MV-22 squadron organization: a different way to support.* U.S. army command and general staff college, Fort Leavenworth, KS. Retrieved from https://apps.dtic.mil/sti/tr/pdf/AD1038750.pdf.

LaGrone, S. (2018, June 19). *Marines pick BAE to build next amphibious combat vehicle to replace decades old AAVs*. USNI News. https://news.usni.org/2018/06/19/marines-pick-bae-to-build-amphibious-combat-vehicle-total-contract-worth-up-to-1-2b

LMI. (2024). LMI History. https://www.lmi.org/about/history

MARADMIN 349/24. Marines.mil. (2024, August 1). https://www.marines.mil/News/Messages/Messages-Display/Article/3857788/fiscal-year-2025-lieutenant-colonel-command-screening-board-results/

Marine Corps Systems Command. (2024, March 14). *Amphibious combat vehicles with Col Tim Hough | Season 3 episode 11* [Video]. Youtube.com. https://www.youtube.com/watch?v=89h9qIyQBqk&t=2505s

Marine Corps Systems Command's Marine Corps Tactical Systems Support Activity (MCTSSA). (n.d.). *Advanced amphibious assault. Assault amphibian community website*. https://usmc.sharepoint-mil.us.mcas-gov.us/sites/ MCSC_MCTSSA_AAA/Pages/Home.aspx#/vehicle/3?tab=Details

Program Executive Officer Land Systems, (2020). *Amphibious combat vehicle (ACV) family of vehicles (FoV) acquisition category 1c life cycle sustainment plan (LCSP): Version 3.0 supporting milestone: Full rate production (FRP)*.

Total Force Structure Management System. (2023a). *AAV CO A 2D AA BN 2D MARDIV*. United States Marine Corps

Total Force Structure Management System. (2023b). *AAV CO B 2D AA BN 2D MARDIV*. United States Marine Corps

Total Force Structure Management System. (2023c). *H&S CO 2D AA BN 2D MARDIV*. United States Marine Corps

Total Force Structure Management System. (2023d). *2D AA BN 2D MARDIV*. United States Marine Corps

Total Force Structure Management System. (2024a). *ACV CO A 3D AA BN 1ST MARDIV*. United States Marine Corps

Total Force Structure Management System. (2024b). *ACV CO B 3D AA BN 1ST MARDIV*. United States Marine Corps

Total Force Structure Management System. (2024c). *ACV CO C 3D AA BN 1ST MARDIV*. United States Marine Corps

Total Force Structure Management System. (2024d*). H&S CO 3D AA BN 1ST MARDIV*. United States Marine Corps

Total Force Structure Management System. (2024e). *3D AA BN 1ST MARDIV*. United States Marine Corps

Training and Education Command. (2024, October 15). *AATOPS 01-ACV-2*. Quantico, VA.

U.S. Marine Corps. (n.d.). Global Combat Support System – Marine Corps, Maintenance Management Report [Data set]

U.S. Marine Corps. (2015, November 11). *Total force structure process (MCO 5311.1D)*. Department of the Navy, Headquarters United States Marine Corps. https://www.marines.mil/portals/1/mco%205311.1e%20z.pdf

U.S. Marine Corps. (2018). *Marine Corps doctrinal publication 3: Expeditionary operations (MCDP 3)*. Department of the Navy.

U.S. Marine Corps. (2023). *Marine Corps tactical publication 3–10C: employment of amphibious assault vehicles (MCTP 3-10C)*. Department of the Navy.

U.S. Code, Title 10, § 5063. (2018). United States Marine Corps: composition; functions.

V-22 Osprey. Marine Aviation. (n.d.). https://www.aviation.marines.mil/About/Aircraft/Tilt-Rotor/

Acquisition Research Program
Naval Postgraduate School
555 Dyer Road, Ingersoll Hall
Monterey, CA 93943

www.acquisitionresearch.net