DEPARTMENT OF THE NAVY
HEADQUARTERS UNITED STATES MARINE CORPS
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LPC-2
23 MAR 2020

MARINE CORPS ORDER 4700.4

From: Commandant of the Marine Corps
To: Distribution List

Subj: ADDITIVE MANUFACTURING POLICY

Ref: See Enclosure (1)

Encl: (1) References
(2) Additive Manufacturing Policy

Reports Required: I. AM Analysis Report (Report Control Symbol EXEMPT), encl (1) chap 2, par 5.f.(4)
II. Product Quality Deficiency Reports on AMOC-approved parts (Report Control Symbol EXEMPT), encl (1) chap 3, par 6.h.(4)

1. Situation. The Marine Corps is embracing emerging technologies by incorporating additive manufacturing (AM) methods to prototype and produce repair parts and innovative solutions. AM is a rapidly advancing manufacturing process which allows direct application to improve the readiness of Marine Corps ground equipment and aviation assets. AM is a secondary source of supply that improves equipment readiness through production at the point of need. Per the references, this Order provides policy and procedures for the integration of AM capability throughout the enterprise to maximize its full potential and ensure that Marine Corps AM efforts are aligned with Department of Defense (DoD) and Department of the Navy (DON) guidance. This Order is in accordance with references (a) through (aa).

2. Mission. Commanders at all levels shall employ and develop additive manufacturing to its fullest extent possible in order to improve combat readiness in garrison and during expeditionary operations.

3. Execution

a. Commander's Intent and Concept of Operations

(1) Commander's Intent. Improve and standardize implementation of AM at all levels of command across the Marine Corps enterprise in both garrison and deployed environments. The desired end state is to leverage AM to the maximum extent to reduce maintenance cycle times, supply chain backlogs, and place manufacturing capabilities at or near the point of need.

(2) Concept of Operations

(a) This Order is directive in nature and encompasses DoD compliant principles and procedures for the management of AM. Enclosure (2) provides detailed policy and procedures in the areas of implementation, manufacturing, aviation, legal considerations, and training.

(b) Commanders shall foster the rapid expansion of the "Marine Maker" culture. This culture empowers Marines with access to AM technologies to create material solutions to address the myriad of challenges they face in garrison and in expeditionary environments. The "Marine Maker" culture encompasses Marines of all military occupational specialties (MOSs) regardless of unit composition or mission.

(c) Deploying units shall integrate AM into their pre-deployment training and operational concepts to increase readiness, generate operational tempo, and deliver capabilities to meet emergent requirements during training and contingency operations. Adding AM into expeditionary operations in support of the current Marine Corps capstone-operating document increases unit capabilities. Accordingly, Marines shall leverage AM in key locations ranging from forward operational bases to logistics installations and austere environments abroad.

(d) Adherence to the provisions in this Order shall ensure accurate accountability of additive manufactured parts and/or equipment and shall promote effective logistics support to the warfighter.

b. Subordinate Element Missions

(1) Deputy Commandant, Installations and Logistics (DC I&L)

(a) Act as the Marine Corps lead for AM by ensuring the roles and responsibilities identified in this Order are adhered to by appropriate stakeholders.

(b) Appoint a Service lead (active duty Marine or government service employee) responsible for AM policy and implementation.

(c) As the Headquarters Marine Corps (HQMC) advocate for AM policy, coordinate policy updates to ensure alignment with DoD and DON policy.

(d) As the HQMC advocate for AM, participate in the OSD led Joint Additive Manufacturing Steering Group (JAMSG), to align strategy, foster collaboration, and leverage resources between services.

(e) Co-chair the Navy Additive Manufacturing Executive Committee to ensure Navy and Marine Corps policies, plans, and goals are synchronized.

(f) Coordinate with the Commanding General, Training and Education Command (CG TECOM) to ensure effective training programs are established and implemented in accordance with this Order.

(g) Ensure that Field Supply and Maintenance Analysis Office (FSMAO) Teams and the Internal Controls and Audit Readiness Team (ICART) inspect Marine Corps organizations for compliance with this Order and assist the Marine Forces (MARFORs) as necessary.

(2) Deputy Commandant, Aviation (DC AVN)

(a) As the advocate for Marine aviation, ensure the implementation of AM technologies throughout the aviation force.

(b) Ensure adequate resources are programmed through the Program Objective Memorandum (POM) process to support AM requirements and ensure the POM is coordinated with N98.

(c) Coordinate policy updates to this Order with DC I&L.

(d) Provide a representative to attend Naval Additive Manufacturing Executive Committee meetings to account for Marine aviation considerations.

(3) Deputy Commandant, Combat Development and Integration (DC CD&I)

(a) Coordinate efforts with DC I&L to ensure effective implementation of this Order.

(b) Ensure adequate resources are programmed through the Program Objective Memorandum (POM) process to support AM requirements.

(c) Coordinate with the DC I&L, Commanding General, Marine Corps Logistics Command (MARCORLOGCOM) and the Commander, Marine Corps Systems Command (MARCORSYSCOM) to ensure Total Force Structure Management System (TFSMS) data reflects the most current and accurate information available to enable effective management of AM equipment.

(d) Ensure future capability development/production documents incorporate AM technology considerations when factoring sustainment of weapon systems by requiring the acquisition of technical data packages (TDPs) which shall enable AM users to produce parts.

(4) Deputy Commandant, Information (DC I)

(a) In conjunction with program managers at MARCORSYSCOM, develop approved hardware and software lists and grant Authority to Operate (ATO) on Marine Corps Enterprise Networks.

(b) Provide a standardized template for Information Technology Procurement Request/Review and Approval System (ITPRAS) requests to support the acquisition of AM hardware and software.

(c) Support MARCORSYSCOM’s implementation of the Marine Corps digital repository with data provenance and security measures.

(d) In conjunction with MCICOM ensure proper funding is allocated to ensure network communication resources and infrastructure are available to enable the use of AM.

(5) Deputy Commandant, Programs and Resources (DC P&R). In coordination with DC I&L, COMMARCORSYSCOM, and DC AVN ensure adequate resources are programmed through the POM process to support Marine Corps AM requirements.

(6) Commanding General, Marine Corps Logistics Command (CG MARCORLOGCOM)

(a) Ensure AM capability and capacity are resident at the organic depot-level to produce/reproduce parts in support of legacy weapon systems.

(b) Lead the application of AM to develop metal and polymer components to sustain legacy weapon systems.

(c) Produce parts in support of material readiness solutions for the fleet beyond Marine Expeditionary Force (MEF) capabilities.

(d) As the Service-level Inventory Control Point, provide materiel management/inventory control support for AM items to MARCORSYSCOM, Program Executive Officer, Land Systems (PEO-LS), and the operating forces.

(e) Establish MARCORLOGCOM AM capabilities as a DoD source of supply.

(7) Commander, Marine Corps Systems Command (COMMARCORSYSCOM)

(a) Develop and sustain a Marine Corps digital repository for AM files and technical data that can be integrated with other Services, Defense Logistics Agency (DLA), and North Atlantic Treaty Organization repositories.

(b) Act as the technical authority for all ground applications of AM. Incorporate AM technologies into sustainment plans for Marine Corps ground equipment, as well as the production of additional combat capabilities such as ordnance, munitions, and construction programs.

(c) Conduct a comprehensive review of existing ground platforms and weapon systems to certify AM-worthy parts that improve performance, readiness, Diminishing Manufacturing Sources and Material Shortage (DMSMS), or cost-avoidance.

(d) Coordinate risk assessments for AM implementation with appropriate Program Offices at MARCORSYSCOM and/or PEO-LS.

(e) Coordinate appropriate cataloging of AM replacement parts with appropriate Program Offices within MARCORSYSCOM, PEO-LS, and Weapon System Management Teams at MARCORLOGCOM.

(8) Commanding General, Training and Education Command (CG TECOM)

(a) Ensure effective training programs for both entry-level and sustainment training of AM.

(b) Coordinate efforts to incorporate formal AM training into the appropriate MOS schools.

(c) Incorporate AM familiarization training into appropriate entry-level officer and enlisted training curriculums.

(d) Establish and support AM training for Marines of all MOSs to build and sustain a culture of innovation throughout the Marine Corps.

(9) Commander, Marine Corps Installations Command (COMMCICOM)

(a) Ensure effective hardware, software, and network communication resources are available to enable the use of AM and Advanced Manufacturing (AVM) at Marine Corps installations.

(b) Requirements to support AM capabilities operated by Marine Corps Community Services (MCCS) organizations shall be coordinated with DC M&RA.

(c) Incorporate AM into base Public Works departments.

(10) Commanders, Marine Corps Forces (COMMARFOR)

(a) Ensure that this Order is available and used by all personnel responsible for the use and implementation of AM.

(b) Commanders at all levels, from tactical units incorporating innovative solutions for battlefield challenges, to intermediate-level activities designing and manufacturing repair parts for the MAGTF, shall employ AM capabilities to the maximum extent possible. For aviation-specific guidance see chapter 4 of enclosure (2).

(c) Commanders in possession of AM equipment shall maintain accountability of these items in an approved accountable property system of record (APSR). Units with access shall use Global Combat Support System-Marine Corps (GCSS-MC). Organizations not supported by GCSS-MC shall account for AM equipment in the Defense Property Accountability System (DPAS). See Chapter 4 for aviation-specific guidance on accountability.

(d) Develop and implement internal command policies and procedures to facilitate the execution of this Order.

4. Administration and Logistics

a. Recommendations concerning the contents of this Order are invited and should be submitted to Assistant Deputy Commandant, Installations and Logistics (LP), Logistics Policy and Capabilities Branch (LPC) via the appropriate chain of command.

b. Privacy Act. Any misuse or unauthorized disclosure of Personally Identifiable Information (PII) may result in both civil and criminal penalties. The Department of the Navy (DON) recognizes that the privacy of an individual is a personal and fundamental right that shall be respected and protected. The DON's need to collect, use, maintain, or disseminate PII about individuals for purposes of discharging its statutory responsibilities shall be balanced against the individuals' right to be protected against unwarranted invasion of privacy. All collection, use, maintenance, or dissemination of PII shall be in accordance with the Privacy Act of 1974, as amended (reference (v)) and implemented per reference (w).

a. Records Management. Records created as a result of this Order shall be managed according to National Archives and Records Administration (NARA)-approved dispositions per reference (t) to ensure proper maintenance, use, accessibility and preservation, regardless of format or medium. Records disposition schedules are located on the Department of Navy/Assistant for Administration (DON/AA), Directives and Records Management Division (DRMD)

portal page at: https://portal.secnav.navy.mil/orgs/DUSNM/DONAA/DRM/Records-and-Information-Management/Approved%20Record%20Schedules/Forms/AllItems.aspx. Refer to reference (u) for Marine Corps records management policy and procedures.

d. Forms Management

(1) Department of Defense (DoD) Forms. All DOD forms are available for download at the DoD Forms Management Program site: https://www.esd.whs.mil/directives/forms/.

(2) Department of the Navy/United States Marine Corps (DON/USMC) Forms. All DON and USMC forms are available for download at Navy forms Online: https://forms.documentservices.dla.mil/order/

5. Command and Signal

a. Command. This Order is applicable to the Marine Corps Total Force.

b. Signal. This Order is effective the date signed.

C. G. CHIAROTTI
Deputy Commandant for
Installations and Logistics

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References

(a) Deputy Secretary of Defense Directive-Type Memorandum (DTM)-19-006, "Interim Policy and Guidance for the Use of Additive Manufacturing (AM) in Support of Materiel Sustainment," March 2019
(b) MCO 4400.201 Vol. 1-17
(c) UM 4000-125
(d) COMNAVAIRFORINST 4790.2C
(e) NAVMC 4790.1B, "Aviation Maintenance Training and Readiness Program," Mar 2019
(f) DON Additive Manufacturing Implementation Plan V2.0, May 2017
(g) MCO 4790.2
(h) DFARS 252.227-7013
(i) DFARS 252.227-7014
(j) Title 10 U.S.C. § 2320
(k) Marine Corps Operating Concept, Sept 2016
(l) Installation and Hybrid Logistics Roadmap, 2017
(m) ASTM 52900:2015
(n) Naval Aviation Additive Manufacturing Guidebook, April 2018
(o) SECNAVINST 4410.23
(p) Title 35, U.S.C.
(q) UTSA (Uniformed Trade Secrets Act)
(r) Title 18, U.S.C.
(s) Title 17, U.S.C.
(t) SECNAV M-5210.1 CH-1
(u) MCO 5210.11F
(v) Title 5 U.S.C. 552a
(w) SECNAVINST 5211.5F
(x) SECNAVINST 5000.2F
(y) Title 15 U.S.C
(z) SECNAV M-5214.1
(aa) MCO 4855.10C

Additive Manufacturing Policy

Chapter 1

Introduction

1. General Overview. This MCO provides policy and procedures governing the implementation of AM in support of ground and aviation operations. Across the Marine Corps, organizations face common operational problems such as equipment obsolescence, DMSMS, long lead times for parts replacement, non-existent parts suppliers, and difficulty in rapidly developing capabilities to defeat new and emerging threats. In a strategic environment where the Marine Corps must fight and win against near-peer competitors in hostile environments, AM creates the opportunity to fully realize the value of distributed operations and close the gaps mentioned above. Due to the versatile nature of AM technology and the speed at which it is advancing, AM has the capacity to revolutionize how the Marine Corps solves maintenance issues, produces innovative solutions, and sustains operational tempo.

a. AM, or 3-dimensional (3D) printing, is a technology with significant implications for the U.S. manufacturing base and naval warfare. It can shorten the design-to-production cycle, enable new designs for a multitude of items, and facilitate cost-effective on-demand manufacturing. AM provides the Marine Corps; increased readiness and increased sustainment. AM also provides Marines the autonomy to solve problems at the forward edge of battle.

b. As AM evolves to produce end-use components, there is significant potential to resolve obsolescence, DMSMS, and long lead time issues. The production of components ‘on demand’ at the point of need shall support a scalable supply chain and enable a new era of supply chain independence.

2. Definitions

a. Additive Manufacturing (AM). A process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies which removes material to manufacture the end product. Synonyms include additive fabrication, additive processes, additive techniques, additive layer manufacturing, layer manufacturing, and freeform fabrication.

b. 3D Printing. The fabrication of objects through the deposition of a material using a print head, nozzle, or another printer technology. This term is often used synonymously with additive manufacturing; particularly with machines that are low end in price and/or overall capability.

c. Advanced Manufacturing (AVM). Use of innovative technologies to create existing products, and the creation of new products. Advanced manufacturing can include production activities that depend on information, automation, computation, software, sensing, and networking. Includes additive, subtractive, and digital manufacturing.

d. Subtractive Manufacturing. Making objects by removing material (e.g., milling, drilling, grinding, carving, etc.) from a bulk solid to leave a desired shape, as opposed to additive manufacturing.

e. Digital Manufacturing. The use of an integrated, computer-based system comprised of simulation, 3D visualization, analytics, and collaboration tools to create products and manufacturing process definitions simultaneously.

f. Manufacturing Activity. An organization that possesses the capability to manufacture parts, pieces, components, sub-assemblies, and items.

g. Computer-Aided Design (CAD). The use of computers for the design of real or virtual objects.

h. Intellectual Property. Refers to a bundle or group of legal rights to stop others from making, using, disseminating, showing, modifying, selling, or offering to sell information, data, technical data, patented inventions, or other classes of protected information protected under a variety of exclusive rights such as copyright, patent, or trade secret law.

i. Maker Space. Maker Spaces are collaborative spaces that allow users access to training, tools, technical skill building workshops, and a network of capable technical experts. Maker Spaces can be fixed, mobile, afloat, deployable, or in virtual space that are equipped with advanced/digital fabrication capabilities that feature AM and associated software. Maker Spaces may be established and manned by any individual unit, a Major Subordinate Command, an installation, or any individual Marine Corps entity that seeks to do so.

3. Additive Manufacturing Process Description

a. The AM process is used to produce items from a medium material, or materials, and a computer design file. AM and conventional subtractive manufacturing are considered components of the larger concept of digital manufacturing. Modern manufacturing of all types involves digital technology. To varying degrees, current manufacturing relies on Computer-Aided Design (CAD) in different ways. AM leverages existing CAD capability. Per reference (m), AM is defined as a “process of joining materials to make parts from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies.” This is unlike conventional subtractive machining, whereby an item is made by cutting away excess stock material to form a desired shape. Modern AM machines use a variety of technologies to perform this process depending on the raw material used, cost considerations, required tolerance, etc. While this Order specifies certain types of equipment and processes for AM, they are subject to change due to rapid advancement of the technology. Figure 1-1 below describes common processes for AM production.

AM Technology	Definition	Common Name	Abbreviation
Vat Polymerization	A process in which liquid photopolymer in a vat is selectively deposited	Stereolithography Digital Light Processing Continuous Digital Light Processing	SLA DLP CDLP
Material Extrusion	A process in which material is selectively dispensed	Fused Deposition Modeling Fused Filament Fabrication	FDM FFF

	through a nozzle or orifice		
Material Jetting	A process in which droplets of build material are selectively deposited	Material Jetting Nano Particle Jetting Drop on Demand	MJ NPJ DOD
Binder Jetting	A process in which a liquid bonding agent is selectively deposited to join powder materials	Binder Jetting	BJ
Powder Bed Fusion	A process in which thermal energy selectively fuses regions of a powder bed	Multi Jet Fusion Selective Laser Sintering Selective Laser Melting Direct Metal Laser Melting Electron Beam Melting	MJF SLS SLM DMLM EBM
Direct Energy Deposition	A process in which focused thermal energy is used to fuse materials by melting as they are being deposited	Laser Engineering Net Shaping Electron Beam Additive Manufacturing Rapid Plasma Deposition	LENS EBAM RPD
Sheet Lamination	AM process in which sheets of material are bonded to form a part	Laminated Object Manufacturing	LOM

Figure 1-1.-- Additive Manufacturing Processes

b. There are many types of digital file formats used for AM. Figure 1-2 below lists the most common formats; however, this is not an all-inclusive list. STL is the oldest and is often the default.

Format	**Description**	**Comments**
.stl	Abbreviation of stereolithography native to CAD software	Most commonly used
.amf	Format that supports color, texture mapping, and meta data	
.3mf	3d Manufacturing Format	New file format set to be the standard format for AM
.x3d	Format for representing and communicating 3d information	
.obj	Geometry definition file format	
.ply	Polygon file format used to store three-dimensional data from 3d scanners	Based on .obj file format
.3ds	Autodesk 3d modeling and animation native file format	
.jt	Siemans 3d modeling native format	
.stp	File extension for a 3d graphic file used by CAD software	

Figure 1-2.-- Additive Manufacturing File Formats

4. Additive Manufacturing Operations. As the Marine Corps conducts distributed operations over greater distances, AM shall enable expeditionary forces to shorten their supply chains, lessen the lead-time for authorized or approved replacement parts or equipment, and allow for the creation of new or cutting-edge capabilities on the battlefield. Within the Marine Corps, AM shall be employed by both the ground and aviation communities from organizational to depot levels. It spans both garrison and forward deployed environments. Specific differences in the acquisition and contracting authorities, business processes, and resourcing to support implementation on the ground and aviation side are addressed in follow-on chapters of this Order. The following introductory guidance is provided for operations at the organizational, intermediate, depot, and installation levels.

a. Organizational-Level Operations. At the organizational level (i.e., battalion/squadron level), commanders shall maintain a basic capability resident within the Tactical Fabrication (TACFAB) System Program of Record (POR) to print parts, tools, and other items from the approved central repository. The ability to develop and employ rapid prototypes shall also reside at this level. Organizational-level deployment of AM currently follows a dual-track implementation. Units are currently creating their own kits based on available unit funds and a MARCORSYSCOM-approved list of devices necessary to build those kits. Concurrently, TACFAB Systems established as a POR are being fielded to provide an additional capability set to all non-aviation organizational-level units across the Service.

b. Intermediate-Level Operations. At intermediate-level organizations (e.g., Intermediate Maintenance Activities (IMAs)), AM capability is centered on the Expeditionary Fabrication (XFAB) System. XFAB is a modular expandable shelter deployed in-concert with the Shop Equipment, Machine Shop (SEMS) developed as an FY-19 POR. XFAB is designed to carry multiple types of AM systems and related tools and is staffed by trained machinists to reflect the fabrication capabilities resident within IMA units. Once expanded to the aviation community, XFAB systems shall reside within the Marine Aviation Logistics Squadron (MALS).

c. Depot-Level Operations. The most robust metal and polymer AM capability shall reside at the depot level. This shall include all types of materials such as specialized metal alloys, specialized polymers, and other exotic materials. These capabilities are located at MARCORLOGCOM and Naval Aviation Fleet Readiness Centers.

d. Installation Operations. Marine Corps bases and stations are foundational to the Maker culture. They play a critical role in providing infrastructure for AM in support of unique, internal requirements, as well the requirements of tenant units. The facilities and areas used to provide an AM capability in garrison are known as “Maker Spaces.” Although any individual unit can establish a Maker Space capability, every base and station shall have a Maker Space, which provides an AM capability proportional to the size and population of the base or station. Many of these spaces (e.g. the Fabrication Laboratory (FabLab) at 29 Palms) will possess rapid prototyping equipment such as Computerized Numerical Controlled (CNC) mills/routers, water jets, laser cutters, micro controllers, and electronic sensors. These facilities shall be sufficiently equipped and resourced with trained personnel to facilitate maximum access to all members of the Marine Corps community. Maker Spaces provide access to AM and AVM equipment to enable exploration and innovation.

e. Non-Conventional Additive Manufacturing. AM is not limited to the manufacture of components and items. In FY-18, the Marine Corps, in conjunction with the U.S. Army Corps of Engineers, began exploring a capability known as Construction-Scale Additive Manufacturing (CSAM). This capability refers to the production of end items such as obstacles, bridges, roads, and structures using concrete. Experimentation has thus far focused on the employment of systems analogous to "conventional" AM devices and the use of a concrete extruder and attachment to construction equipment to print large items in place. In addition to ongoing concrete CSAM efforts, the Marine Corps is collaborating with the Naval Warfare Center Pacific to produce the first prototype forty-foot ship-to-shore connector via large-scale metal AM.

5. Additive Manufacturing Equipment. For the purpose of this Order, an AM facility is a covered area for processing pieces, parts, components, and items that take into consideration temperature and humidity requirements for proper equipment operation and quality control. Equipment required to process such items may consist of, and is not limited to, the following:

a. Desktop AM printers

b. Large scale AM printers

c. Sandblasting stations

d. Support material removal machinery

e. Drill press

f. Wash station

g. Various tools and special tools required

h. Drafting tables/stations

i. Various types of saws (band, table, scroll, etc.)

j. Sanding stations

k. Inspection equipment for quality control purposes

l. Computers with appropriate software to design end items and operate equipment

6. Additive Manufacturing Data Management. AM implementation requires the user to develop, store, analyze, and transmit protected TDPs. This information is known as the "digital thread". This requires infrastructure such as 3D-scanners, high-performance computers, and storage; production software for CAD, 3D scanning software, and other design software; storage and transmission infrastructure to protect and distribute design files securely. To date, AM machines themselves do not have ATO on the Marine Corps Enterprise Network, which has impeded developing the capability. AM devices, at a core level, are not dissimilar from other multi-functional devices and should be treated accordingly.

a. Digital Repository. Critical to the use and success of AM across the Marine Corps is a digital thread capable of cataloging, editing, and providing for engineering design updates and changes. These data repositories are central locations in which AM files, TDPs, best practices, and associated information is stored. Currently, there are two data repositories in the Marine Corps.

(1) The current ground equipment repository is located at https://innovatedefense.net/marine-maker

(2) The aviation equipment repository is located at www.jtdi.mil

b. The long-term goal is to establish a POR-style Digital Manufacturing Data Vault.

Chapter 2

Implementation

1. General Information. This chapter delineates policy and procedures required to develop, integrate, and operationalize AM across the Marine Corps. It provides detailed roles and responsibilities to implement AM policy. Additionally, it shall optimize partnerships and engagement with other DoD entities such as the Naval Additive Manufacturing Executive Committee, the Naval Additive Manufacturing Technology Interchange, academia, and industry sources at all levels.

2. Governance. Oversight of AM implementation is the responsibility of DC I&L Supply Policy and Capabilities Branch (LPC-2). To facilitate coordination efforts, an AM Implementation Working Group has been established with representation from DC I&L, DC AVN, MARCORSYSCOM, MARCORLOGCOM, TECOM, and the operating forces (OPFOR) to assess the need for changes to existing policies, procedures, standards, and internal controls. Compliance of this Order shall be assessed by the regional FSMAO teams and ICART.

3. Implementation Tasks. Despite the divided nature of requirements, resourcing, and employment of AM between aviation assets and ground equipment, commonalities exist. To facilitate the implementation of AM throughout the enterprise, the following tasks are prescribed by functional area.

a. Policy

(1) Task: Establish a Memorandum of Understanding (MOU) between MARCORSYSCOM, MARCORLOGCOM, Naval Air Systems Command (NAVAIR), Naval Information Warfare Center (previously Space and Naval Warfare Systems Command (SPAWAR)), and Commander, Fleet Readiness Centers to establish an interchange and governance board for AM acquisitions policy. Office of Primary responsibility (OPR): MARCORSYSCOM.

(2) Task: Annually meet with Subject Matter Experts (SME) from DC I&L, DC AVN, MARCORSYSCOM, MARCORLOGCOM, and the OPFOR, to review this order and provide changes as necessary. OPR: DC I&L. Office of Coordinating Responsibility (OCR): DC AVN, and MARCORSYSCOM.

(3) Task: Incorporate AM into future policy updates. OPR: DC I&L.

b. Training. Current guidance to ensure standardization of AM training throughout the enterprise is provided in Chapter 6 of this Order. While fabrication has traditionally been relegated to the Machinist and Metal Worker MOSs, opportunities must be expanded to all MOSs.

(1) Task: Conduct a manpower training analysis to expand implementation of AM capabilities to all MOSs. OPR: DC CD&I. OCR: Deputy Commandant Manpower and Reserve Affairs (DC M&RA), DC I&L, and DC AVN.

(2) Task: Determine a roadmap and incorporate AM training within the appropriate MOS-schools and develop a training program to create a necessary MOS for additional capability. OPR: DC CD&I. OCR: DC M&RA, DC I&L, and DC AVN.

(3) Task: Develop a commander's education course on the use and employment of AM. OPR: DC CD&I. OCR: DC I&L.

(4) Task: Develop an AM Marine Net course to enable fleet-wide engagement and education. OPR: DC CD&I. OCR: DC I&L.

c. Resourcing. Continued resourcing of AM facilities, equipment, software, and supporting capabilities shall facilitate the adaptation of AM and the innovative, problem-solving culture across the Service. This includes resourcing the expansion and inclusion of Maker Spaces across the Marine Corps.

(1) Task: Continue the creation and resourcing of Maker Spaces across all bases and stations and applicable commands throughout the operating forces. OPR: DC I&L. OCR: DC P&R and MARCORSYSCOM.

(2) Task: Establish a Digital Manufacturing Data Vault POR to begin in FY-21. OPR: MARCORSYSCOM. OCR: DC CD&I and DC I&L.

(3) Task: Develop an interim secure digital repository to bridge the gap until the fielding of the Digital Manufacturing Data Vault Program. OPR: MARCORSYSCOM. OCR: DC CD&I.

(4) Task: Ensure the AM digital repository is capable of information sharing with Joint and Coalition partners. OPR: MARCORSYSCOM. OCR: DC I and DC I&L.

(5) Task: Leverage economies of scale for the procurement and licensing CAD and AM-related software requirements to include AM programs of record and Maker Spaces. AM-related software must be accessible on the Marine Corps Enterprise Network. OPR: MARCORSYSCOM. OCR: DC I.

d. Acquisition and Legal. Traditionally, the Marine Corps has relied on external vendors for parts and supplies, while the Service's machinists and metal workers have focused on repair rather than new or mass production. Once AM is fully employed, it will create legal and procedural questions not covered in this Order. Additionally, to fully realize AM capability, any new system acquired must enter the inventory "AM ready." Therefore, coordinating TDP acquisition and "AM worthiness" as common features of systems acquisition must be considered.

(1) Task: In addition to Chapter 5 in this Order, develop authoritative legal guidance on issues related to AM. OPR: Council for the Commandant and Staff Judge Advocate to the Commandant. OCR: MARCORSYSCOM.

(2) Task: Develop and implement a strategy to incorporate AM principles into the acquisition process and supply chain inclusion. OPR: MARCORSYSCOM. OCR: MARCORLOGCOM.

(3) Task: Comprehensively review existing ground platforms and weapon systems to certify AM-worthy parts which improve performance, readiness, obsolescence-risk, DMSMS, or cost-avoidance. This shall include a requirement for the incorporation of technical, legal, and other reviews. OPR: Staff Judge Advocate to the Commandant and MARCORSYSCOM. OCR: DC I&L and DC CD&I.

4. Aviation-Specific Implementation. The following aviation-specific roles, responsibilities, and policy shall be followed to ensure proper authorities, acquisition and contracting, and accountability of AM-produced items.

a. Aviation Logistics Support Branch (ASL). DC AVN (ASL) shall serve as the lead advocate for implementation of AM capabilities throughout Marine Corps aviation. In collaboration with DC I&L, NAVAIR, and Commander Naval Air Forces (CNAF); DC AVN (ASL) shall explore, exploit, and transition new concepts, technologies, and AM capabilities from industry and the DoD. The following responsibilities shall also be accomplished:

(1) Provide advocacy for Marine Aviation during the establishment of the Naval Aviation POR.

(2) Participate as a working member of the AM Executive Committee EXCOMM hosted by DC I&L, Navy N95, and the Deputy Assistant Secretary of the Navy for Research Development Test and Evaluation.

(3) Maintain the Marine Corps aviation collaboration website.

(4) Incorporate AM into future policy updates.

(5) Account for AM assets on the Table of Basic Allowances (TBA).

b. Aviation Operating Forces. Commanders at all levels should seek to employ AM capabilities to the maximum extent possible by working with intermediate-level and depot-level maintenance activities to design and submit AM component requests to the NAVAIR AM Integrated Product Team (IPT) or to MARCORSYSCOM as prescribed in the Acquisition and Contracting paragraph below.

c. Authorities

(1) NAVAIR is the authority for airworthiness determinations. This includes any class of unmanned aerial systems (UAS) operating at any Marine Corps unit. Refer to Chapter 4 for the AM approval process for UAS. The authorized digital repository for on aircraft components and equipment is located at the Joint Technical Data Integration website. CNAF is the authority for aircraft configuration.

(2) Marine Corps aviation commands shall use hardware and software approved by DC I that is compatible with Marine Corps Enterprise Networks. Information technology assets shall be requested via the standardized template for ITPRAS.

d. Acquisition and Contracting

(1) NAVAIR is the acquisition authority for Marine aviation.

(2) MARCORSYSCOM may be utilized for items or parts as long as those parts are not utilized on aircraft or aviation associated equipment.

e. Accountability

(1) AM equipment shall be added to the TBA. This addition shall be temporary while AM is in the process of becoming a POR. Once this occurs, 3D printers, hardware, and software shall fall under the maintenance Individual

Material Readiness List (IMRL) Program and shall be tracked via standard IMRL procedures.

(2) All initial inventories shall be conducted to record nomenclature, serial number, and quantity. All results shall be provided to DC AVN (ASL-31).

(3) Ensure only current TBA guidelines/requirements are followed when adding AM equipment to the TBA.

5. Ground-Specific Implementation. There are unique acquisition, contracting, policy, training, and resource considerations to support the ground-specific implementation of AM. These considerations are addressed in organizational-specific tasks below to ensure AM is fully implemented across the Marine Corps ground community from organizational through depot levels.

a. Deputy Commandant, Installations and Logistics (DC I&L)

(1) Coordinate required updates to policy and provide advocacy for AM.

(2) Coordinate with CD&I and MARCORSYSCOM to establish a POR to ensure AM capability is fully funded across the Future Years Defense Program and allocate adequate resources to allow for expansion as AM technology matures.

(3) Coordinate with MARCORSYSCOM to incorporate AM into sustainment of Marine Corps ground equipment. Incorporate AM capabilities to include Class I and Class II unmanned aerial systems, ordnance, and construction programs.

b. Deputy Commandant, Combat Development and Integration (DC CD&I)

(1) Formalize AM requirements documentation and incorporate AM capability into all future requirements documents of new weapon system development and fielding.

(2) Ensure AM is integrated in the Total Force Structure Process and establish Approved Acquisition Objectives for AM equipment throughout the enterprise.

c. Marine Corps Installations Command (MCICOM)

(1) MCICOM shall serve as the lead for ensuring Marine Corps installations are properly equipped to support AM.

(2) Incorporate AM into Base Public Works Departments.

d. Marine Corps Systems Command (MARCORSYSCOM)

(1) MARCORSYSCOM shall serve as a lead and shall address AM in a comprehensive manner mirroring industry. By establishing a consolidated Advanced Manufacturing Operations Cell (AMOC), MARCORSYSCOM shall advance the Service’s goal to employ AM throughout the Marine Corps.

(2) Act as the technical authority for all ground applications of AM. Incorporate AM and 3D printing into sustainment of Marine Corps ground equipment.

(3) Standardize AM equipment sets (hardware and software) to include expeditionary AM assets, when applicable.

(4) Develop and sustain the Marine Corps digital repository to include AM lessons learned.

(5) Manage approval requests for AM produced parts and items. Establish a 24-hour help desk to rapidly respond to end user requests for AM support.

(6) Develop and maintain intellectual property guidelines and standards as they apply to acquisition of new ground systems, as well as reproduction of parts for sustainment of legacy ground systems.

(7) Coordinate risk assessments for AM replacement parts with appropriate Program Offices and/or MARCORSYSCOM Command Safety.

(8) Assist with AM policy development, AM equipment accountability, and integration with GCSS-MC.

(9) Develop a MARCORSYSCOM rapid prototyping facility and micro-factory to print/fabricate fleet items for testing and validation.

(10) Develop prototypes to incorporate into existing systems or future systems and develop capabilities for rapid fielding to meet Urgent Needs Statements or other emerging requirements.

(11) Establish agreements (e.g. Cooperative Research and Development Agreements) and competitive contracts with entities within the AM industrial base to include commercial partners, research labs and academia, to expand AM opportunities, capabilities and capacity in support of the Marine Corps.

(12) Foster tactical-level innovation and advanced manufacturing skill building through Marine Maker training.

(13) Advance the state-of-the-art of battlefield AM to include programs such as large/construction scale AM and AM for repair.

f. Marine Corps Logistics Command (MARCORLOGCOM)

(1) MARCORLOGCOM shall provide a coordinating and oversight role in AM as it relates to fleet equipment readiness. MARCORLOGCOM shall ensure that subordinate commands (Marine Depot Maintenance Command, Blount Island Command, Marine Force Storage Command) are sufficiently resourced to fully exploit AM technologies.

(2) Establish, sustain, and expand an industrial scale AM and AVM capabilities at Marine Corps depots to facilitate sustainment, repair, and low rate of initial production for Marine Corps weapon systems and items. Ensure AM capacity and capability are resident to lead the use of AM in maintenance.

(3) Act as ambassadors by interfacing with local, state, and federal government officials, industry partners, chambers of commerce, economic development groups, and universities, colleges and schools to develop opportunities for collaboration on AM.

(4) Produce an annual analysis report to determine the value of AM across the enterprise as compared to traditional sources of supply and to ensure AM is being employed in the most effective manner, both in a readiness and fiscal sense. This report shall be provided to DC I&L. This reporting requirement is exempt from reports control according to reference (z), Part IV, paragraph 7.q.

(5) Monitor equipment readiness, informed by current, enterprise-wide AM capability, to determine which parts have the most impact on short and long-term readiness.

(6) Lead the application of AM to develop metal and polymer components to sustain legacy weapons systems.

(7) Establish, sustain, and expand a rapid prototyping and micro-manufacturing facility to print/fabricate fleet items for testing and validation.

(8) Develop prototypes for MARCORLOGCOM to incorporate into existing systems or future systems and develop capabilities for rapid fielding to meet Urgent Needs Statements or other emerging requirements.

g. Training and Education Command (TECOM)

(1) Ensure efforts are coordinated to codify formal training programs to incorporate AM training into appropriate MOS schools. Incorporate AM familiarization training into appropriate entry-level officer and enlisted training curriculums.

(2) Establish and support Marine Maker training for Marines of all MOSs to build and sustain a culture of innovation throughout the Marine Corps.

h. Operating Forces

(1) Adhere to the policy and procedures in this Order for the utilization of AM capabilities.

(2) Commanders at all levels, from tactical units incorporating innovative solutions for battlefield challenges, to intermediate-level activities designing and manufacturing repair parts for the MAGTF should seek to employ AM capabilities to the maximum extent possible. This includes the establishment of applicable Maker Spaces.

(3) All initial inventories shall be conducted to record nomenclature, serial number, and quantity.

6. Morale Welfare and Recreation Specific Implementation

a. DC M&RA

(1) Serve as the lead for ensuring all MCCS organizations are properly equipped to support AM.

(2) Establish non-appropriated fund policy for charging authorized patrons for consumable materials utilized within Maker Spaces.

(3) Serve as the POM advocate for MCCS operated Maker Spaces.

(4) Ensure MCCS Maker Spaces are sufficiently equipped and resourced with trained personnel to facilitate maximum access. Exhaust all efforts to equip Maker Space facilities with equipment such as CNC mills/routers, water jets, robotic kits, micro controllers and laser cutters.

b. MCICOM. In coordination with DC M&RA, establish Maker Spaces featuring 3D printing on every Marine Corps base and installation and ensure these spaces are open to authorized MCCS patrons.

Chapter 3

Manufacturing Process

1. General Information

a. This chapter is the authoritative source of policy and procedures related to AM in support of Marine Corps ground equipment. It provides detailed supply and maintenance management procedures for AM implementation within GCSS-MC. The policy within this chapter ensures that AM actions are standardized, repeatable, and auditable for the enterprise.

b. As a warfighting organization, the Marine Corps constantly seeks methods which increases its ability to respond to operational challenges faster than its adversaries. AM allows the organization to respond to supply-chain challenges to harnesses technologies that enable the individual Marine to conceptualize, model, prototype, develop, and produce viable solutions for an unresponsive source of supply (SoS) part. AM provides an opportunity to avoid long lead times due to part non-availability and/or adverse distribution channels under emergent conditions. When determining feasibility, unit commanders shall account for: personnel safety, equipment damage, risk assessment, and mission accomplishment.

2. Measures of Effectiveness

a. The Marine Corps shall capture AM metrics to determine manufacturing cycle time, throughput, and fill rates to facilitate analysis of the supply chain, maintenance production rates, labor hours, and facilities requirements.

b. The standardized procedures in this chapter shall minimize training requirements for personnel involved with AM while increasing effectiveness across the logistics chain. These procedures are intended to be repeatable in the same manner under the same conditions with minimal adjustment to the tools, tooling, or supporting systems and devices to ensure data consistency. AM procedures must be auditable and show a complete data information trail (i.e., “digital thread”) within the authoritative data source and APSR. This ensures all data is measurable.

3. Roles and Responsibilities

a. Commanders at all levels are authorized to manage and employ AM equipment, production material, and subsequent manufactured/fabricated items in direct support of the warfighter. This includes the modeling of prototypes and fabricating pieces, parts, sub-components, and assemblies’ components that are within a Military Equipment’s Bill of Materials unless otherwise restricted. Military Equipment refers to Marine Corps ground equipment assigned a Table of Authorized Materiel Control Number (TAMCN).

b. Training aides, tools, innovative solutions, and tooling are authorized to be additively manufactured. The requirement to serialize or place these items on the unit property records shall be addressed on a case-by-case basis. Unit commanders reserve the right to establish local controls in accordance with reference (b).

c. Levels of Maintenance

(1) Organizational Maintenance Activities

(a) Organizational units are authorized to procure AM equipment assigned a Type 2 TAMCN per reference (b).

(b) Type 2 TAMCN AM equipment shall have unit-level allowances established and shall be accounted for in GCSS-MC.

(c) Initially, organizational units shall be restricted to polymer printers; however, this shall be reassessed as technology matures.

(d) Units are encouraged to mutually support other organizations with AM support.

(e) Organizational units shall directly communicate with the MARCORSYSCOM AMOC and collaborate with other manufacturing activities through the digital repository and other Maker Space initiatives.

(f) Units shall document AM actions within GCSS-MC to maintain an audit trail, digital thread, measure the effectiveness of AM procedures and capture National Item Identification Number (NIIN) demand.

(2) Intermediate Maintenance Activities (IMAs)

(a) IMAs are authorized to procure AM equipment assigned a Type 2 TAMCN per reference (b). AM equipment assigned a Type 1 TAMCN shall normally be procured by MARCORSYSCOM and fielded to owning activities. All AM equipment assigned a TAMCN shall be accounted for in GCSS-MC.

(b) Intermediate activities are authorized to procure AM equipment through commercial sources when the items have not been assigned a TAMCN. See paragraph 4 in this chapter for accountability guidance of these assets.

(c) IMA capabilities include, but are not limited to polymers, metals, and extensive post-production capabilities.

(d) IMAs shall directly communicate with the AMOC and collaborate with other manufacturing activities through the digital repository and other Maker Space initiatives.

(e) IMAs shall document AM actions within GCSS-MC.

(3) Depot-Level Maintenance Activity (DMA)

(a) The DMA shall account for AM equipment within the APSR per reference (b). See paragraph 4 in this chapter for accountability of these assets.

(b) The DMA’s AM capabilities are not limited and include industrial-level manufacturing capabilities.

(c) The DMA shall directly communicate with the AMOC and collaborate with other manufacturing activities through the digital repository.

d. Supporting Establishments

(1) Training Activities

(a) Training activities (e.g., includes formal schoolhouses like the 2161 Machinist school) that possess organic or intermediate-level manufacturing capabilities can produce AM parts to support training activities.

(b) Training activities shall account for AM equipment per paragraph 4 in this chapter.

(c) Training activities shall directly communicate with the AMOC and collaborate with other manufacturing activities through the digital repository.

(d) Document all AM actions within GCSS-MC.

(2) MARCORSYSCOM

(a) The AMOC at MARCORSYSCOM shall facilitate the qualification and approval of AM parts designed by maintenance activities at all levels. This includes the creation of technical requirements for AM parts fabrication and shall include relevant technical data, drawings, material types, post AM processing requirements, and final inspection requirements for fabricated parts.

(b) The AMOC shall facilitate management of the digital repository, a collaborative website where manufacturing activities can share and download AM design and print files (TDPs) and view the status of part approvals throughout the AMOC approval process.

(c) The AMOC is the liaison between the requester and the approving authority for all parts.

(d) The AMOC shall facilitate the approval or disapproval of submitted parts with the part’s Program Managers.

(e) The AMOC shall man a 24/7 AM helpdesk reachable at parts_helpdesk@usmc.mil or via the MARCORSYSCOM Officer of the Day at (703) 432-3966.

(f) Program Offices shall facilitate the provisioning of Marine Corps NIINs and Commercial and Government Entity (CAGE) Codes for approved parts that have an order of use, or parts that the supply system identifies as a substitute or alternate to the SoS part to avoid introducing counterfeit parts into the Marine Corps.

(g) Per reference (o), Program Offices shall facilitate assignment of the 6th digit (Service Option Code) of “6” to the Source Maintenance Recoverability Code (SMR Code) for approved part NIINs. This shall ensure visibility of approved AM parts within GCSS-MC.

(h) The AMOC shall document manufacturing actions within GCSS-MC.

(3) Installations. Installation AM activities (e.g., Maker Spaces, Facilities Maintenance, etc.) shall provide a mix of organic and intermediate AM capabilities to organically support themselves and tenant commands.

4. Accountability of AM Equipment. AM equipment (e.g., 3D printers, XFAB modular expandable shelters, etc.) shall be categorized as military equipment or garrison property. The following guidance for accountability of these assets applies.

a. Military equipment. Per Volumes 1 and 3 of reference (b), AM equipment assigned a TAMCN and associated Approved Acquisition Objectives are considered centrally managed military equipment and shall be accounted for in GCSS-MC. This includes Type 1 and Type 2 TAMCN items.

b. Garrison property. Per Volume 15 of reference (b), AM equipment purchased from commercial sources (e.g., low-end 3D printers) and not assigned a TAMCN are considered garrison property and are not deployable. Accountability requirements depend on the unit price of the equipment.

(1) Equipment with a unit price below $5,000 does not require accountability within an APSR per reference (b). These items shall be accounted for on local accounting records.

(2) Equipment with a unit price of $5,000 or greater shall be accounted for within DPAS per reference (b). Commanders of tenant organizations aboard a Marine Corps installation must identify these items to the Base Property Control Office to load the items to the Custody Asset Report for the owning organization. Cataloging shall be accomplished by MCICOM via routine processes.

5. Additive Manufacturing Part Approval Process

a. Overview

(1) The MARCORSYSCOM Program Offices are the approval authority for the manufacture of ground equipment replacement parts. Approval of a part is a determination that the part is a suitable replacement or a minimally viable substitute for the original equipment manufacturer part.

(2) This Order establishes four color coded “bins” to facilitate the AM part approval process. The four bins are:

(a) Green. The part is approved for use.

(b) Yellow. The part is in the initial design phase (prototyping) prior to submission for the approval process.

(c) Blue. The part is in the approval process and design refinement.

(d) Red. The part is not approved for use.

(3) The four bins are broken down as follows:

(a) Green Bin

1. Parts in the green bin require no additional approval for production and use.

2. Repair parts in the green bin have been approved for use as either an alternate SoS or a reasonable substitute as determined by the Program Office. The TDP of an approved part shall provide details.

3. Green bin parts are assigned an SMR Code of X (no longer procurable or requires requisitioning of the next higher assembly) or M (authorized for local manufacture).

4. Per reference (o), green bin parts include an SMR Code Service Option Code (6th digit) of "6."

5. Green bin parts can be printed by the Marine Corps network of producers. The approved TDP shall be followed. For example, if an MLG organization produces parts for a MALS, the MLG must follow the established NAVAIR-approved TDP.

6. Some green bin parts have a low risk factor that does not warrant the approval process. Nevertheless, these items still require uploading data to the digital repository to allow information sharing, tracking, and assigning of an appropriate 6th digit SMR Code. These items include the following and therefore can be printed at the discretion of the user:

a. Items whose form, fit and function characteristics require no analysis of performance impacts prior to use.

b. Stand-alone items such as hand tools, jigs, table models, training aids.

c. Facility items such as doorknobs, hinges, and HVAC components that have no safety of life or limb ramifications should they fail.

d. Carrying handles, blocks, braces, or similar items.

e. Innovative solutions to tactical problems that pose low risk to personnel or equipment should they fail.

(b) Yellow bin

1. The primary purpose of the yellow bin is to serve as an initial evaluation and data collection period by end users that shall be used to inform the follow-on approval process.

2. Designs for repair parts start their lifecycle as yellow bin items. This includes innovative ideas that pose a moderate risk to personnel or equipment in the event of failure.

3. Yellow bin parts are to be uploaded and shared in the digital repository. This allows for fast refinement and iteration of designs.

4. Designers and end users are authorized to print yellow bin parts to test fit, form, and perform limited function checks. A limited

function check involves testing the AM part in a manner that poses no reasonable risk to personnel or equipment. This prototyping shall be used to populate the TDP and design that shall be submitted to inform the approval process.

5. In cases where failure of an AM item poses moderate risk to personnel or equipment, the commanding officer shall perform an appropriate risk assessment. This assessment shall inform the decision to submit the TDP and perform limited function checks. Cases where the failure of an AM item would pose high risk to personnel or equipment shall move from the yellow bin to the red bin.

6. Yellow bin parts in the digital repository are available to print with the understanding they are simply prototypes undergoing refinement and evaluation. End users shall help inform the TDP building process by offering feedback, refinements, and recommendations.

7. When the design has completed testing for form, fit, and limited function, it shall be transferred to the Blue bin, which initiates the approval process.

(c) Blue bin

1. Blue bin parts begin the approval pipeline.

2. Blue bin parts in the digital repository can be printed and used with the understanding they are undergoing evaluation for approval. End users shall help inform the TDP building process by offering feedback, refinements, and recommendations.

3. Yellow bin parts shall enter the blue bin when they are approved for full function check by the commander of the equipment for which the repair part is to be applied or the innovative solution is to be implemented.

4. The commanding officer shall evaluate the risk associated by performing a full function check of the AM part experienced during operational conditions.

a. Should the commanding officer approve the full function check, the part shall undergo evaluation. Evaluation results shall be recorded in the TDP and be submitted to the AMOC for approval or further binning.

b. Depending on the risk assessment, should the commanding officer not approve a full function check, the part, risk assessment, and TDP shall be submitted to the AMOC for further evaluation and refinement by the respective Program Office. Reasons for disapproval by the commanding officer shall be included in the submission to inform the evaluation process.

5. Parts requests and associated TDPs shall be submitted to the AMOC for approval. The AMOC shall route to the appropriate Program Office. The AMOC serves as the technical authority on AM within the Marine Corps and shall help inform the Program Office’s decision through production of parts, testing, and evaluation in a laboratory or field environment. This stage of the evaluation process is a collaborative effort between the Program

Office, the submitting organization, and the AMOC to refine a submitted design.

6. Upon completion of testing, evaluation, and design refinement, the Program Office shall decide whether a submitted part is a green bin or red bin item. Limits on use and function determined by the Program Office shall be noted in the TDP to inform end users of any restrictions or caveats for using the item.

(d) Red bin

1. Red bin items are currently not approved for production through AM means.

2. When a part is determined as a red bin item by the Program Office, clarification shall be documented within the digital repository and the GCSS-MC Service Request under “Tasks.”

3. Commanders have the authority to print and use red bin parts as a temporary solution in cases where successful completion of operations is at risk and an appropriate risk assessment has been completed and attached to the manufacturing Service Request.

4. Red bin parts may be reassessed for approval as the AM environment changes.

6. Ground Manufacturing Procedures

a. Overview

(1) The following procedural instructions shall guide GCSS-MC users in the request and documentation of AM actions for ground equipment. To facilitate this process, several additions have been incorporated into the GCSS-MC Service Request (SR) form, debrief form, parts requirement form (shopping cart), and the reporting tool (Oracle Business Intelligence Enterprise Edition (OBIEE)).

(2) Manufacturing within the Marine Corps is defined as non-traditional SoS capabilities that enable the design and production of parts, pieces, assemblies, and components from a variety of equipment that includes, but is not limited to: 3D printers, mills, lathes, drills, welders, water jets, and software programs that enable their operation.

b. Concept of operations

(1) Figure 3-1 depicts the process flow for fulfilling a parts requisition via additive manufacturing. GCSS-MC users must incorporate the below procedures to ensure manufacturing actions inform the supply chain. These steps include the introduction of a new SR type: Maintenance – Manufacture. This SR shall be created to capture the type of manufacturing machine used to produce the AM part. The Maintenance – Manufacture SR must be related to the originator’s SR utilizing the “Copy to” function. This shall enable the tracking of manufactured parts applied to military equipment and the analysis of manufacturing production metrics.

(2) The below ground part requisition process depicts actions that both the requesting unit and the supporting maintenance activity must follow

to properly request and document manufactured items via the AM process. Additional actions are required to submit a part approval request to the AMOC and when applying a yellow, red, or blue part that is not depicted in this business process.

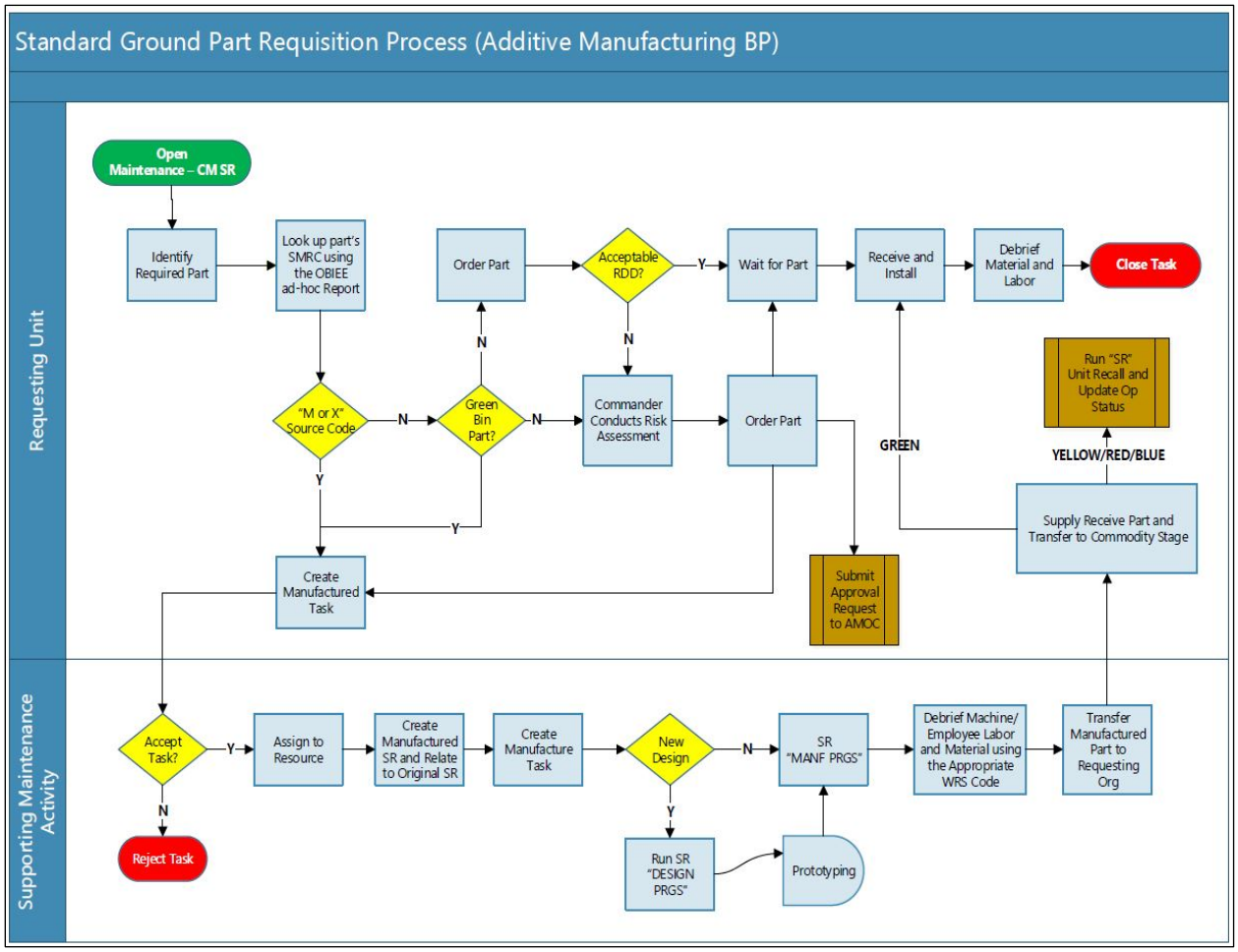


Figure 3-1.-- AM Part Requisition Process Flow

c. Technical research for part requirements using the SMR Code

(1) During the parts requisition phase, maintainers are encouraged to research whether the part can be manufactured via AM. Per reference (o), MARCORSYSCOM-approved parts are designated by the SMR Code. If the 6th digit (Service Option Code) is "6," it indicates that an item, which is normally procured commercially, can be manufactured to fill emergency stop gap requirements.

(2) Organic manufacturing sources should be reviewed when commercial sources cannot meet demand.

(3) SMR Codes with the 6th digit of "6" indicate AMOC-approved items that are deemed as a suitable substitute replacement part.

(4) If a MARCORSYSCOM-approved part does not have an updated 6th digit SMR Code, contact the associated item manager to update the SMR Code in Catalyst.

(5) The “SM&R Query” OBIEE ad-hoc report shall be used to determine the full 6-digit SMR Code for any Marine Corps authorized NIIN found in the GCSS-MC Item Master. This ad-hoc report pulls NIIN attribute data on the GCSS-MC/CATALYST data interface to display all six characters of the SMR Code. This information shall be used to make sourcing decisions from the retail supply activity, and to determine if a part is authorized to be manufactured locally.

(6) In accordance with reference (o), “M” source coded items can be manufacturing locally.

d. Manufacturing activities shall document manufacturing production actions via the Maintenance – Manufacture SR against the Installed Base item that is used to manufacture the part (i.e., lathe, mill, 3D printer, welder). Subsequent manufacturing actions shall be tracked on the initial Manufacture SR as additional tasks. Maintenance – Manufacture SRs must be related to the originator’s SR to maintain visibility of manufacturing actions.

e. Yellow, blue, and red bin repair parts

(1) Yellow, blue, and red bin repair parts may be applied while the unit requisitions the part through traditional means (i.e., Supply Management Unit).

(2) Parts in the blue bin may be manufactured and applied to ground equipment with approval from the commanding officer after a risk analysis has been conducted.

(3) Units shall place military equipment with a yellow or red bin part applied in a “unit recall” SR status. The equipment shall return to the maintenance activity once the SoS part is received or the yellow, blue, or red bin part is approved by the MARCORSYSCOM Program Office.

(4) Equipment owners shall be informed if there is a yellow, blue, or red bin part on their equipment, and the receiving responsible officer is required to evaluate the risks associated and upload the risk assessment to the equipment SR.

(5) With yellow or blue bin parts applied, the equipment’s operational status should be considered Operational – Minor, or Operational – Degraded.

(6) Yellow, blue, or red bin items are not authorized to be applied to SAC 2, secondary reparable items.

f. Tracking manufactured parts approved by commanders

(1) Parts that are not approved by the MARCORSYSCOM Program Office can be applied to military equipment. Commanders must assign a risk severity to manufactured parts by nature of the risk. Once the part is applied, the operational status of the equipment shall be updated to reflect the current status.

(2) Military equipment with a yellow, blue, or red bin part applied that is not approved by the MARCORSYSCOM Program Office must have an approved requisition for the required part to the SoS to establish demand.

(3) If the yellow, blue, or red bin part is later approved by the MARCORSYSCOM Program Office, the part requisition to the SoS can be cancelled.

g. Capturing the time to design and manufacture parts. To capture the time required for Marines to design and manufacture parts, the Maintenance - Manufacture SR has two status types: Design in Progress, and Manufacture in Progress.

(1) Design in Progress should be used to identify when the part is under active design (modeling and prototyping).

(2) Manufacture in Progress should be used to identify when the part is undergoing fabrication/manufacturing.

h. Documenting the production of manufactured parts

(1) Manufactured parts shall be gained into perpetual inventory, receipted for, and consumed by the unit to show usage/consumption.

(2) Manufactured parts are gained into the perpetual inventory by performing a negative material debrief ("return to inventory").

(3) Once the part has been gained to the perpetual inventory, the manufacturing unit's supply section can sub-inventory transfer the part to the unit's 01A to issue from inventory, or conduct a material move order to the originator's 01A to allow receipt and debrief actions for the part against the original Maintenance – CM SR.

(4) Per reference (aa), commanders shall submit Form SF 368, "Product Quality Deficiency Report" on AMOC-approved parts when they are determined unserviceable. This reporting requirement is exempt from reports control according to reference (z), Part IV, paragraph 7.k.

(5) Manufactured parts without assigned NIINs are a common occurrence. Fleet identified AM parts without a NIIN shall be assigned one through the appropriate MARCORSYSCOM Program Office.

i. Debriefing manufactured parts

(1) Several Material Usage Codes have been added to the material debrief form to gain better visibility of manufacturing methods used to make the AM parts (see Figure 3-2).

(2) The requestor shall view the Maintenance – Manufacture SR to see which manufacturing method was used to produce the part and shall ensure the same method is used when performing a positive material debrief.

Code	Title	Description
AM	Additive Manufactured item	3D printed using direct metal, fused deposition, or other similar AM methods

SM	Subtractive Manufactured item	Traditional machining processes using mills, lathes, drills, shaping, planning, honing or other similar machining methods
JW	Joined/Welded item	Welding with arc, oxyfuel, resistance, percussion, brazing, soldering, induction, sintering, fastening, adhesive, pinning, solid state or other similar welding methods
FM	Formed item	Forming, forging, rolling extruding, pressing, bending, shearing, stamping or other similar manufacturing methods
MD	Molded item	Powder metallurgy, plastic molding, lamination, injection or spray forming, plastic injection or other similar manufacturing methods.
IM	Imaged item	Imaging, laser engraving, depositions, plating, chemical vapor or sputter deposition, thermal spraying or other similar imaging methods.

Figure 3-2.-- Material Debrief Types

j. Debriefing machine labor

(1) The time the manufacturing equipment was used to manufacture parts shall be debriefed as machine labor.

(2) Machine labor shall be used in manufacture tasks to capture the duration of time manufacturing equipment operated while producing parts.

k. Ordering manufactured parts from Marine Corps units through the supply system

(1) Retail supply units possess the ability to place an administrative hold on specified requisitioned NIINs through a process called “operational coding” or op-coding.

(2) MARCORSYSCOM Program Office-approved part NIINs can be op-coded.

(3) Units can order manufactured parts with an Acquisition Advice Code of MN and a Signal Code of D. MN is a USMC only recognized Advice Code used to identify a part requirement that is locally manufactured or fabricated.

(4) The requesting unit should contact the supporting entity at the organizational, intermediate, or depot level to facilitate production and delivery of the AM part.

(5) Part demands with an MN Advice Code cannot be passed to DLA.

(6) Manufactured parts shall be packaged in accordance with Volume 14 of reference (b) when shipped.

l. Perpetual inventories shall not be stocked with manufactured parts to reduce negative supply chain effects. The exception being for the immediate issue from a maintenance action.

m. Manufacturing consumable material (i.e., welding rods, AM filament, AM support material, sheet metal, etc.) are not required to be debriefed.

n. Manufactured tools, tooling, training aides and displays shall be documented in a Maintenance - Manufacture SR.

o. Transferring equipment with an unapproved part applied

(1) Military equipment may be transferred to another unit with a yellow, red, or blue bin part applied that was not approved by the appropriate MARCORSYSCOM Program Office.

(2) The equipment shall have a SR established with a “UNIT RECALL” status to follow the equipment when it is transferred. The gaining command can decide whether to accept the risk of using the equipment and wait for the SoS part to arrive or reject the equipment.

Chapter 4

Aviation

1. General Information

a. AM for aviation is currently employed by industry, academia, and across the DoD. This chapter addresses AM policies, procedures, and responsibilities for the implementation and employment of AM at all levels of maintenance and in concurrence with NAVAIR and CNAF policy. AM information processes shall be pushed to the depot, intermediate, and organizational levels of maintenance. AM for aviation shall be employed at the manufacturing levels of maintenance which encompass the intermediate-level squadrons and depots. The organizational level shall remain focused on supporting MAGTF operations by maintaining aircraft and equipment in a mission capable status while improving local maintenance processes. At the intermediate level, there is significant potential for AM to resolve obsolescence, DMSMS, and long lead time issues that can hinder the organizational-level mission.

b. AM is not limited to improving readiness through manufacturing aircraft components, but also through everyday tooling and job aid production which saves direct maintenance man hours, and by prototyping to set quality standards for future prints. Aviation units other than MALS and operational-level flying squadrons (i.e., MWSS, LAAD, MWCS, MWHS, MACG, MASS, MTACS etc.) are authorized to refer to the ground annex of this policy and utilize the MARCORSYSCOM digital repository. MALS and operational-level flying squadrons are not authorized to utilize the MARCORSYSCOM digital repository for on aircraft components or for equipment utilized on aircraft or aircraft equipment, nor shall any of the aforementioned components be shared outside of the NAVAIR Joint Technical Data Integration (JTDI) repository website. The JTDI website shall be utilized for all AM aircraft components and components that support tooling, job aids, ground support equipment, IMRL assets, and mobile facilities.

c. Except as prescribed in this chapter, Marines serving in aviation units shall follow the policy as prescribed throughout this Order. This chapter is applicable to all Air Wing, MALS, O-level line squadrons, VMX, and HMX-1 commanders.

d. The decision to AM components applicable to aircraft and aircraft equipment components shall be decided at the intermediate level (I-level) and depot levels of maintenance when one or more of the following conditions are met:

(1) The original equipment manufacturer (OEM) part is obsolete.

(2) The OEM part is available, but the timeline to receive the part does not meet mission requirements.

(3) The requesting unit is operating beyond the lines of communication where supply chain support is unavailable or unknown.

(4) Manufacturing a subcomponent shall save the unit from having to order the next higher assembly.

e. Additive manufacturing of components that do not pertain to aircraft or associated equipment such as Ground Support Equipment, IMRL, tooling used to work on aircraft, or equipment that touches aircraft, and mobile facilities shall be encouraged and do not require approval beyond the unit level.

f. Job aids and tools are the responsibility of the Quality Assurance Division and shall be uploaded to the JTDI website prior to use (see Appendix E to review the required form and review JTDI for submittal procedures). Calibrated items must be requested through the NAVAIR triage process as outlined in paragraph 3 of this chapter.

g. All organizational-level (O-level) squadrons shall be supported with I-level AM capability and qualified personnel, to include when forward deployed.

h. Acquisition method. Additional equipment and filament shall be ordered via non-standard procurement, otherwise referred to as open purchase. Units are authorized to expand the quantities of equipment listed on the AUL. Supporting hardware to printers on the AUL, such as extruder heads and variation of filament, is authorized at local unit discretion.

i. MALS leadership shall engage O-level leadership to ensure awareness of AM capability. O-level involvement in assisting to identify AM candidates is necessary and shall benefit the aviation enterprise.

j. The JTDI website is the only technical data package repository authorized to host STL files for DON aviation components, to include job aids and tools. To compliment JTDI, the MILSUITE collaboration website is a tool for sharing best practices and lessons learned, information on the AM process, to include, but not limited to, industrial health surveys, ITPRAS and equipment information, training, orders, and directives. Marines serving within aviation that are associated with the AM work center shall become members of the following two websites:

(1) WWW.JTDI.MIL

(a) Once on the website, click on “register” in the “log in using your CAC” bin.

(b) Fill in starred bined, where applicable.

(c) Fill in the Security Office POC or Gov’t Sponsor Information:

1. Charles Browne or Elizabeth McMichael

2. 301-342-3104

3. NAVAIR_AM_FCT@NAVY.MIL

(d) Click “save”

(e) Reason for access: Fleet user

(f) Service: click on “Navy/Marines” to see list of services.

(g) Click on “AM” (2nd from top of list)

(h) Click on “acknowledgement”

(i) Click on “request access”

(2) https://www.milsuite.mil/book/groups/marine-aviation-additive-manufacturing-maam (join the group on the website)

k. DC AVN (ASL) is responsible for the accuracy, currency, and modification of this chapter. Recommendations concerning the contents of this chapter shall be forwarded to DC AVN (ASL-33) via the appropriate chain of command.

2. Subordinate Element Tasks

a. Marine Force Commands shall coordinate with and resource subordinate units to support AM implementation at the lowest tactical level. Licensing keys for software shall be annotated in the Statement of Work for recovery of software as necessary.

b. AM is intended for use by every MOS. Commanders shall use talent management to identify Marines across aviation MOSs and Marines assigned in support of aviation units to participate in AM, and possible assignment to the AM Work Center located at the MALS.

c. Marine Air Wings are accountable for submiting 3-D printers, scanners, software, and computer assets, by unit, to DC AVN (ASL-31) for accountability and shall ensure units are in compliance with the Authorized Equipment List published by the DC AVN (ASL-31). Deviations to the Authorized Equipment List can be requested by contacting DC AVN (ASL-33).

d. MALS commanders and aviation supply departments are responsible for the timely submittal of a Demand History Allocation (DHA). DHA demand transactions are used in the establishment or cancellation of demand transactions between Stock Control Activities and Issue Control Points. DHA submittals are required when the following two criteria are met:

(1) The decision to AM components for aircraft or associated equipment is made.

(2) The requisition document is cancelled.

3. Naval Aviation AM Submission Process for Aircraft Components and Associated Equipment

a. Nomination of AM aircraft components. When nominating a component for AM, the end state is a digital TDP that shall inform users on how to locally produce the requested components or obtain the component from an approved source. The TDP shall include documented processes and procedures for a successful print, as well as the required data files (imbedded attachments) for printing, inspecting, and processing the part for use. The first step of the nomination process is to provide detailed information to the NAVAIR AM team. Follow-on communication between engineering and the requestor shall maximize efficiency and accuracy. Nomination of AM components shall be submitted to navair_am.fct@navy.mil. Per the NAVAIR AM Fleet Part Request Form downloadable from JTDI, requests shall include:

(1) Component Information

(a) Type/Model/Series Aircraft

(b) NSN or NIIN

(c) Part Number

(d) Description of part requested

(e) Maintenance manual reference

(f) Picture of requested part

(2) Requestor Information

(a) Title/Rank

(b) First Name

(c) Last Name

(d) Phone Number

(e) Email Address

(f) Organization

(g) Signature on AM Part Request Form prior to submittal via JTDI

b. Once the AM Fleet Request Form is signed, save and upload the form to JTDI to complete the nomination process. In the event JTDI is inaccessible and only as a last resort, the requestor shall email the form to NAVAIR via email at the following email address: navair_am.fct@navy.mil.

c. The NAVAIR AM team shall contact the requestor within three working days to acknowledge the request, and to collect any additional information required to start the engineering triage process. To inform the TDP development process, requestors should identify available on-hand printers and materials when requesting items to NAVAIR that are intended for fleet manufacture.

d. Nominated aircraft components shall fall into one of four categories.

(1) Yellow. Yellow bin category items are designated as “triage in progress” in advance of assignment to green, blue, or red bin categories. Manufacture of yellow bin items is not NAVAIR-approved in advance of a category determination. NAVAIR shall update the list of yellow category items weekly to identify the length of time in the triage process; length of time in triage is calculated as days between the receipt of request and date of the report. The status detail column on the NAVAIR_Yellow_Triage_List posted to the JTDI website provides information on where the item is in the triage process. Data Incomplete status indicates items that have been submitted and have insufficient data to process for classification. Requesters must resubmit those items with complete data. Templates for request submissions that include all required data are available on the AM JTDI website.

(2) Green. Green bin category items are NAVAIR-approved items on the NAVAIR Green Bin/AM Qualified Parts List (QPL) for AM manufacture. AM QPL items in the green bin category have no airworthiness or safety implications and are approved for fleet manufacture. Installation of AM QPL parts on aircraft must comply with CNAF policy per reference (d).

(3) Blue. Blue bin category items are NAVAIR classified items that have airworthiness, safety, and/or mission performance requirements. Items on blue bin list that have approved blue category AM TDPs are on the NAVAIR AM QPL. NAVAIR manages and controls all approved blue bin category AM TDPs and does not provide access to them on the JTDI site; however, a list of blue bin components is available for visibility. NAVAIR AM manufacturing site qualification requirements are categorized into four (4) levels based on the complexity and criticality of AM items and associated quality management standards, processes, and certifications required for manufacturing sites. Fleet requests for access to blue bin TDPs shall be requested by emailing the NAVAIR AM team at NAVAIR_AM.FCT@NAVY.MIL. There are blue bin components in a deferred status that are awaiting resources to develop technical data. Fleet users are encouraged to re-request these components should they continue to be problematic.

(4) Red. Red bin category items are not NAVAIR-approved for AM. Red category parts are evaluated based on the criticality and complexity of the component, time and cost to develop AM TDPs, and the availability of NAVAIR-approved AM technology. Red bin categorized items with technical maturity as basis of disapproval shall be re-evaluated annually as AM technology matures. Program Management Aviation (PMA) deferred parts as basis of disapproval have poor return on investment based on cost of the current supply posture. These items shall be re-evaluated at PMA’s request or at the fleet’s request.

Chapter 5

Legal Considerations

1. General Information. This chapter provides guidance on Intellectual Property (IP) rights. The intent of this chapter is to orient the reader to various legal issues and terms that could arise when dealing with AM. This chapter is not a substitute for legal advice. Commanders and "Marine Makers" should consult their Staff Judge Advocate with any follow-on questions or specific legal issues. Intellectual property generally refers to a bundle or group of legal rights to stop others from making, using, disseminating, showing, modifying, selling, offering to sell, etc., information, data, technical data, patented inventions, or other classes of protected information protected under a variety of exclusive rights such as copyright, patent, or trade secret law.

2. Types of Intellectual Property

a. Patent. This is the grant of a property right to the inventor, issued by the U.S. Patent & Trademark Office. A patent gives the owner the right to exclude others from making, using, offering for sale, or selling the invention in the U.S. or importing the invention into the U.S. Types of patents include:

(1) Design (i.e., new, original and ornamental designs for articles of manufacture). See sections 171-173 of reference (p).

(2) Utility (i.e., new and useful process, machine, manufacture, composition of matter, and any new and useful improvement thereof). See sections 171-173 of reference (p).

b. Trade Secrets. Trade secrets are defined as:

(1) Information that (1) “derives independent economic value, actual or potential, from not being generally known to, and not being readily ascertainable by proper means by other persons who can obtain economic value from its disclosure or use,” and (2) “is the subject of efforts that are reasonable under the circumstances to maintain its secrecy” per section 1(4), of reference (q).

(2) Information can be virtually any type, including “a formula, pattern, compilation, program, device, method, technique, or process.” (See Section 1(4), of reference (q)). Examples of trade secrets include the formula for Coca-Cola® and the recipe for Mrs. Fields® Chocolate Chip cookies.

(3) The Economic Espionage Act (see sections 1831-1839 of reference (r)) makes it a crime to steal trade secrets. The Trade Secrets Act (see section 1905, of reference (r))) makes it a crime for a federal government employee to release confidential or proprietary information gained during their employment in an improper manner.

c. Copyright. Copyright laws give the author of an original work, a bundle of five exclusive rights (see section 106 of reference (s)) as follows:

(1) The right to reproduce the copyrighted work

(2) The right to prepare derivative works based upon the original work

(3) The right to distribute copies of the work to others

(4) The right to perform the work in public

(5) The right to display the work in public

(6) Types of original works that can be copyrighted include:

(a) Literary works

(b) Musical works (including accompanying words)

(c) Dramatic works (including accompanying music)

(d) Pictorial, graphic and sculptural works

(e) Sound recordings

(f) Architectural works

(7) No copyright exists, from the beginning, in any governmental work. A governmental work is defined as any work created, modified, or improved by various officers and employees of the government acting in the scope of their official duties; however, the government may own copyrights via assignment (see section 105 of reference (s)).

d. Trademarks

(1) Trademarks allow manufacturers and service providers to use marks (i.e., signs, symbols or insignias, and sounds) that distinguish their goods or services from the goods and services of others (see section 1127 of reference (y)).

(2) Trademarks protect a company’s goodwill and enable customers to be sure they are receiving a certain quality of goods or services. Examples include:

(a) Trademarks (Nike Swoosh)

(b) Service marks (Jiffy Maid for janitorial services)

(c) Collective marks. Used by members of an organization or group to distinguish their products or services from non-group members (e.g., Professional Golf Association)

(d) Certification marks. Used to show the product or service meets certain characteristics or function levels (Underwriters Laboratories).

3. Government Rights in Technical Data

a. While the government does indeed own technical data created by government employees, the government does not own technical data or software created or delivered by a contractor under a government contract. Rather,

the government receives a license to that technical data, colloquially called "data rights." The level of data rights the government receives under a government contract is a function of the type of data, or the funding used to develop the item. See section 2320 of reference (j) and related Defense Federal Acquisition Regulation Supplement (DFARS) clauses (e.g., DFARS 252.227-7013 and DFARS 252.227-7014).

b. For an item developed exclusively at government expense, the government has Unlimited Rights to the technical data. Unlimited Rights means the government may "use, modify, reproduce, perform, display, release, or disclose" the tech data to anyone and for any purpose.

c. For items developed exclusively at private expense, the government shall receive only Limited Rights to the technical data. With only Limited Rights, the government may "use, modify, reproduce, perform, display, release, or disclose" the data only within the government, but may not use the Limited Rights data to manufacture. The exceptions to this restriction are that the government may release to another if "necessary for emergency repair and overhaul," may release to "covered government support contractors," and may release to a foreign government for educational and informational purposes. The government may also negotiate for additional rights, for example to support competitive sustainment, but a contractor may not be forced to yield such additional rights, and the cost of same may be unaffordable.

d. For an item developed at both government and contractor expense, in any proportion, the government obtains Government Purpose Rights. Government Purpose Rights means the government may "use, modify, reproduce, perform, display, release, or disclose" the data within the government, or may release or disclose such data to someone outside the government so long as the recipient signs a required Non-Disclosure Agreement committing the recipient to the tech data only for governmental purposes. This restriction expires, generally five years after contract award, at which time the Government Purpose Rights convert to Unlimited Rights.

4. Commercial Rights in Technical Data. The government usually only obtains those rights in commercial technical data that the public would receive when purchasing that same commercial item. There are some exceptions, such as data necessary for operation, maintenance, installations or training; modifications made to the item at government expense to meet government requirements; and form, fit and function data (i.e., data describing the overall required physical, functional and performance characteristics of an item, component or process enough to allow identification of physically and functionally interchangeable items).

5. Specifically Negotiated License Rights. The government contracting officer has the discretion to negotiate variance from the traditional data rights described above, so long as the government receives no less than Limited Rights in non-commercial technical data. Commercial technical data rights can be negotiated as well but like non-commercial data rights, any negotiated rights must be incorporated into the contract.

6. Decision Process for Sourcing AM Technical Data Packages. To facilitate the decision process for sourcing AM TDPs, an explanation of the Decision Tree in Figure 5-1 below is in order.

a. The first step is to identify the need for a replacement part or a new part, and to decide whether the government possesses the data necessary to additively manufacture the part. If yes, does the government have the rights to print the part? Example: Are there legal restrictions to be considered like patent or copyright infringement, data rights restrictions that preclude manufacturing the part, or distribution statements that impact the necessary distribution of the technical data? After considering these questions, the government could choose to manufacture the part itself or have a third party manufacture it.

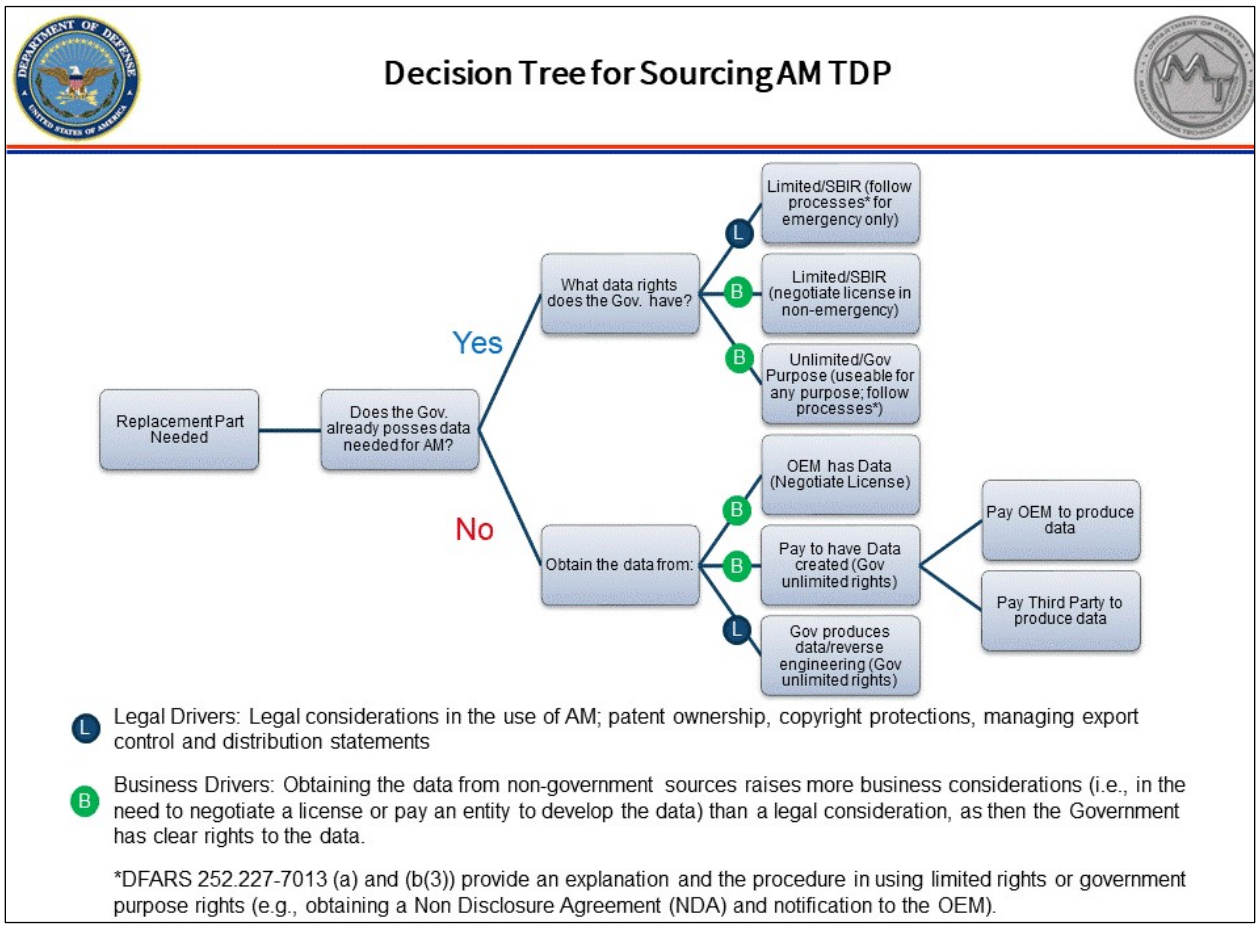


Figure 5-1.-- Decision Tree for Sourcing AM TDP

b. If the government does not possess the data needed to additively manufacture the part, a decision must be made to obtain this information. The government has three choices to obtain the technical data necessary to manufacture the part:

(1) Negotiate a license to obtain or use the technical data from the OEM (assuming the OEM already possesses an AM TDP.

(2) Contract with the OEM to pay for the AM TDP, or contract with (pay) a third party to create an AM TDP by reverse engineering the part.

(3) Have government personnel reverse engineer the part to create the AM TDP. Reverse engineering presents risks since even a perfect copy of the

structure of a part may not reproduce the OEM material characteristics or essential manufacturing processes.

7. Weapons, weapon systems, including non-lethal weapons

a. Requirement. Pursuant to reference (x), all weapons and weapon systems must undergo a legal review to ensure consistency with domestic and international law. Ref (x) requires that modifications to weapons and weapon systems (including non-lethal weapons) must receive a new legal review. All modification requests shall be vetted through the local Staff Judge Advocate who shall forward all weapon and weapon system modification requests to the Staff Judge Advocate to the Commandant (JAO). If a part is reverse engineered for a weapon or weapon system, such weapon or weapon system must undergo additional testing to ensure the modification does not result in any enhancement or changes to the effects it would have on the intended target or to collateral persons or objects.

b. Definitions

(1) Weapon or Weapon System. As referred to in this section, weapons or weapon systems are defined as all arms, munitions, materiel, instruments, mechanisms, devices, and those components required for their operation, that are intended to have an effect of injuring, damaging, destroying, or disabling personnel or property, to include non-lethal weapons.

(2) Modifications. As referred to in this section, modifications are defined as any change, addition, enhancement, or improvement to a weapon or weapon system which adds, changes, or enhances effects of injuring, damaging, destroying, or disabling personnel or property. This includes effects to either the target or to collateral persons or objects.

8. Example Scenarios. The following example scenarios describe the decisions and follow-on actions an AM practitioner may encounter.

a. Traditional Government Acquisition

(1) The government is acquiring a fighter jet and has determined in its logistics support plan that it requires the ability to make parts in the field. Accordingly, within the Request for Proposal (solicitation), the government identifies the need for the technical data with the rights to produce certain parts. The government has identified the landing gear as a critical part, and knobs which are non-critical parts. The government must decide whether it will produce the parts or engage an industry partner to print the parts.

(2) In this scenario, the government has requested up front the rights in technical data to be included in the Request for Proposal. The government has indicated their lifecycle sustainment strategy of additively manufacturing parts. There are several directions the government may take.

(a) Continue with the OEM to additively manufacture the parts required, thus avoiding the need to license an AM TDP.

(b) The government shall produce the part internally, either licensing the AM TDP from the OEM or developing its own AM TDP via reverse engineering.

(c) The government shall source the part to a third party to additively manufacture, again either licensing for the AM TDP or producing it via reverse engineering.

(3) If the government continues with the OEM to produce the part, the rights to technical data and print quality remains with the OEM, as well as configuration control. The print configuration, machine setup, and post processing remain with the OEM. As far as contracting and intellectual property is concerned, this decision is no different than contracting for a traditionally manufactured part.

(4) If the government chooses to produce the part internally, the first step is to reference the Decision Tree in Figure 5-1. If licensing from the OEM, the government should request the information on how the OEM is manufacturing the component. For example, the type of AM machine including the model and version, the parameters the machine was set to include powder specifications, orientation of the part on the build surface, and any support strategy. Quality assurance and testing procedures should be included. Lastly, post processing of the part should be included in the requirement setting.

(5) If the part will be produced by a third-party supplier, all the information required in paragraph 8.a.(2) must be obtained, either licensing with the OEM or developing it independently. In addition, the concern for data security must be addressed.

b. Legacy Military Platforms

(1) The government issued a contract for a military platform 10 years ago. Now the government determines it needs the ability to make parts in the field and the government has technical data with the Limited Rights restriction. Alternatively, the government may have no current access to the technical data.

(2) In one case, the supply chain is too slow to deliver the sustainment part to a remote area for the remainder of a deployment.

(3) In another case, the government needs to repair the platform to return it to operational condition.

(a) Is the part a candidate to be additively manufactured?

(b) Determine what information and rights the government has and whether it is sufficient to additively manufacture parts. The Decision Tree in Figure 5-1 should be referenced to ensure the technical data and associated rights are available. Access to the technical data with sufficient rights to additively manufacture parts is key to manufacturing parts in the field. If the technical data is available, the government must decide if the data is current, and if the data is in a form suitable to support additively manufacturing the parts (e.g., CAD and .STL format). If the information is not available, a reverse engineering task could be required.

c. Diminishing Manufacturing Sources and Material Shortage (DMSMS)

(1) Private Industry has moved on and is no longer interested in supporting a legacy system. Commercial sources of supply and repair no

longer exist. Technical data is not available and must be generated through reverse engineering, or data is available but suitable rights need to be negotiated between the data owner and the government.

(2) If the OEM or data owner do not agree to provide the information, or if the information is no longer available, the only alternative is to reverse engineer the part and create the AM TDP. Reverse engineering could be done directly by the government or could be contracted to a third party. Either way, the government must generate and maintain the information.

(3) If the technical data is available, the government should negotiate with the OEM or data owner to supply the rights in technical data for the part. The Decision Tree in Figure 5-1 should be referenced to ensure sufficient rights are available.

d. Print on Demand

(1) Printing a non-critical part that has been reverse engineered by the government shall require no further contracting action, unless the printing is done by a third party. It is assumed the government would have sufficient technical data, the associated rights, and the printing capability. For general availability of technical data, and to assist in avoiding duplication, such AM TDPs should be included into a DoD-wide digital repository of printable parts.

(2) A scenario when the government pays only per printed item assumes there is an up-to-date database of authorized parts available for printing. This digital repository must be negotiated up front to ensure parts and process information is available and current.

Chapter 6

Training

1. General. This chapter provides commanders with initial guidance for conducting AM training within the Marine Corps. During initial implementation of AM, the Marine Corps has successfully demonstrated the ability to positively affect readiness and allow Marines to innovate. The Marine Corps shall continue to invest in AM education and training to develop skills and increase knowledge. The training guidance in this chapter is designed to synchronize training standards across the enterprise. This Order does not prohibit untrained Marines from experimentation or prototyping.

2. Training Standards

a. The purpose of establishing standardized formal training levels for AM is to enable a way to track individual Marines' knowledge of AM processes. Accordingly, TECOM has established levels of AM training (see Figure 6-1) to categorize proficiency levels and technical capabilities of Marines trained in AM.

Training Level	Description
Familiarization training	Introductory awareness training for all hands consisting of AM capabilities and program familiarization.
Level 1: Operator	Level 1 training consists of teaching Marines to operate printing equipment and print approved items.
Level 2: Incidental Programmer	Level 2 training consists of CAD, operation of a slicer program, printing non-critical materials, performing basic maintenance on printing equipment, and submitting technical data for approval.
Level 3: Formally Trained	Level 3 training consists of advanced CAD programming, reverse engineering, structural analysis, equipment maintenance, and material selection.

Figure 6-1.-- Additive Manufacturing Training Levels

b. TECOM has established training and readiness (T&R) events and standards related to AM located within the Marine Corps Training Information Management System (MCTIMS). Marine Aviation AM T&R events can be accessed via the Advanced Skills Management (ASM) System. These training events are designed to be used by any MOS, and any community may link them to their own T&R Manual. The AM T&R events shall remain in a digital format and is located in MCTIMS and ASM. These T&R events shall be used by TECOM and the Tri-MEF Working Group to produce AM training curriculum.

c. In the future, TECOM shall review the possibility of creating an AM sub-task under the Marine Corps task of "conduct logistics." TECOM shall work with appropriate advocates to incorporate this guidance throughout the development of formal standards and training as the capability progresses.

3. Curricula Types

a. Training conducted by entities outlined in this chapter shall be tracked in MCTIMS and ASM. Training entities shall provide trained personnel

documentation indicating the date and title of the course, AM T&R tasks trained, and the level of training achieved. This document shall be used by the Marine's command to log and track AM training. Marines that received AM training prior to the issuance of this Order are authorized to update their training records in accordance with the guidelines of this chapter. Initially, the MEFs shall inherit the Formal School Code responsibilities of staffing and maintaining the Additive Manufacturing Training Centers (AMTCs). A Local School Code shall be established and used to track Marines that have received AM training.

b. Any MOS that finds it beneficial to incorporate AM training into their curriculum and training are authorized to do so. Schoolhouse curriculum developers are encouraged to coordinate with AMTCs or Maker Spaces to develop appropriately scoped AM instruction fitting their specific needs.

c. AMTCs are training entities that are dedicated to training Marines on AM and Marine Corps centric AM processes. Each MEF shall establish, man, and operate an AMTC to foster greater adoption of AM. Each AMTC shall be staffed and managed in accordance to each individual MEF's capabilities. Each training center's staff must take part in the Tri-MEF AM Working Group headed by DC I&L. This shall ensure that the periods of instruction remain consistent across the Marine Corps as well as adapting new AM technology, policy, and procedures. DC I&L, with DC AVN in support, shall lead course curriculum reviews as appropriate. Marine forces not associated with a MEF may coordinate with the AMTCs to train personnel.

d. AMTCs are authorized to contract out to academia, private business, or Marine Maker training subject matter experts.

e. Maker Spaces are training entities and collaborative spaces that allow users access to tools, technical skill building workshops, and a network of capable technical experts. Maker Spaces may be established and manned by any individual unit, a Major Subordinate Command, an installation, or any individual Marine Corps entity that seeks to do so. Maker Spaces shall coordinate with local AMTCs, the Tri-MEF Working Group, other Maker Spaces, and the AMOC to design their curriculum. Maker Spaces are encouraged to run skill-building workshops, to include AM. AM workshops shall include an instruction on Marine Corps AM policy.

f. Maker Spaces that are operated by the installation are for personal use only and are not to be used for military application without proper vetting through the established approval process.

g. The Marine Maker Innovation Bootcamp (IBC) is a training entity focused on maker skill-building that is conducted by a mobile training team. The training teaches CAD, 3d printing, circuitry, robotics, basic programming, and other rapid prototyping techniques. The Marine Maker IBC is managed and coordinated by the AMOC. Local commanders may contact the AMOC to schedule IBC training.

h. Units are authorized to coordinate with training entities outside the Marine Corps to include academia, private industry, or other government agencies to receive AM training. Prior to conducting outside training, requesting units should verify that the period of instruction is in accordance with established T&R standards. Additionally, establishing contracts for training which exceed the small purchase threshold must be coordinated with the regional contracting office.

i. The bulk of the 3D printers found outside of intermediate-level repair facilities shall be commercial off the shelf consumer-grade desktop printers. Because of this and the widespread placement of the technology in the civilian education system, it is very realistic that Marines shall have received perfectly suitable training in operator-level AM equipment and software outside of the sanctioned Marine Corps courses listed above. The Marine Corps shall leverage this to its advantage. Marines with prior AM training can receive a vetting workshop from AMTCs or Maker Spaces to verify their proficiency with equipment and software sets used by the Marine Corps, and their familiarity with AM policy and procedures in this Order.

j. Personnel assigned to depot-level maintenance facilities and IMAs may require more in-depth training due to the complex nature of tasks associated with these activities. Training for these types of machines and the associated software can be coordinated through the Naval Surface Warfare Center Carderock, the original equipment manufacturer, or via contracted training.

Appendix A

Glossary of Key Terms

3D printer. A machine used for 3D printing.

3D printing. The fabrication of objects through the deposition of a material using a print head, nozzle, or another printer technology.

Note: This term is often used synonymously with additive manufacturing; in particular associated with machines that are low end in price and/or overall capability.

3D scanning. A method of acquiring the shape and size of an object as a 3-dimensional representation by recording x, y, z coordinates on the object's surface and through software the collection of points is converted into digital data. Typical methods use some amount of automation, coupled with a touch probe, optical sensor, or other device. Synonym: 3D digitizing.

Additive Manufacturing (AM). A process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies. Synonyms: additive fabrication, additive processes, additive techniques, additive layer manufacturing, layer manufacturing, and freeform fabrication.

Additive Systems. Machines used for additive manufacturing.

Advanced Manufacturing (AVM). Use of innovative technologies to create existing products, and the creation of new products. Advanced manufacturing can include production activities that depend on information, automation, computation, software, sensing, and networking. Includes additive, subtractive, and digital manufacturing.

Binder Jetting. An additive manufacturing process in which a liquid bonding agent is selectively deposited to join powder materials.

Computer-Aided Design (CAD). The use of computers for the design of real or virtual objects.

Computer-Aided Manufacturing. Typically refers to systems that use surface data to drive CNC machines, such as digitally driven mills and lathes, to produce parts, molds, and dies.

Computer Numerical Control. Computerized control of machines for manufacturing. Common CNC machines include mills, lathes, grinders, and flame, laser, and water-jet cutters.

Direct Metal Laser Sintering. A powder bed fusion process used to make metal parts directly from metal powders without intermediate "green" or "brown" parts. Synonym: direct metal laser melting.

Facet. A three or four-sided polygon that represents an element of a 3D polygonal mesh surface or model. Triangular facets are used in STL files.

Fused Deposition Modeling. A material extrusion process used to make thermoplastic parts through heated extrusion and deposition of materials layer by layer.

Digital Manufacturing. The use of an integrated, computer-based system comprised of simulation, 3D visualization, analytics, and collaboration tools to create products and manufacturing process definitions simultaneously.

Directed Energy Deposition. An additive manufacturing process in which focused thermal energy is used to fuse materials by melting as they are being deposited.

Initial Graphics Exchange Specification. A platform neutral CAD data exchange format intended for exchange of product geometry and geometry annotation information.

Intellectual Property. Refers to a bundle or group of legal rights to stop others from making, using, disseminating, showing, modifying, selling, or offering to sell information, data, technical data, patented inventions, or other classes of protected information protected under a variety of exclusive rights such as copyright, patent, or trade secret law.

Inventory Control. That phase of military logistics that includes managing, cataloging, requirements determinations, procurement, distribution, overhaul, and disposal of materiel. Also called inventory management, materiel control, materiel management, supply management.

Inventory Control Point (ICP). An organizational unit or activity within the DoD supply system assigned the primary responsibility for materiel management of a group of items either for a particular Military Department or for the DoD as a whole. In addition to materiel management functions, an ICP may perform other logistics functions in support of a particular Military Department or for a particular end item (e.g., centralized computation of retail requirements levels and engineering tasks associated with weapon system components).

Laser Sintering. A powder bed fusion process used to produce objects from powdered materials using one or more lasers to selectively fuse or melt the particles at the surface, layer by layer, in an enclosed chamber.

Note: Most laser sintering machines partially or fully melt the materials they process. The word “sintering” is a historical term and a misnomer, as the process typically involves full or partial melting, as opposed to traditional powdered metal sintering using a mold and heat and/or pressure.

Maker Space. Maker Spaces are collaborative spaces that allow users access to training, tools, technical skill building workshops, and a network of capable technical experts. Maker Spaces can be fixed, mobile, afloat, deployable, or in virtual space that are equipped with advanced/digital fabrication capabilities that feature AM and associated software. Maker Spaces may be established and manned by any individual unit, a Major Subordinate Command, an installation, or any individual Marine Corps entity that seeks to do so.

Manufacturing Activity. An organization that possesses the capability to manufacture parts, pieces, components, sub-assemblies, and items.

Material Extrusion. An additive manufacturing process in which material is selectively dispensed through a nozzle or orifice.

Material Jetting. An additive manufacturing process in which droplets of build material are selectively deposited. Example materials include photopolymer and wax.

Powder Bed Fusion. An additive manufacturing process in which thermal energy selectively fuses regions of a powder bed.

Proof of Concept. Evidence, typically derived from an experiment or pilot project which demonstrates that a design concept, business proposal etc., is feasible.

Prototype Tooling. Molds, dies, and other devices used to produce prototypes; sometimes referred to as bridge tooling or soft tooling.

Prototyping. Preliminary model of something from which other forms are developed or copied.

Rapid Prototyping. Additive manufacturing of a design, often iterative, for form, fit, or functional testing, or combination thereof.

Rapid Tooling. The use of additive manufacturing to make tools or tooling quickly, either directly, by making parts that serve as the actual tools or tooling components, such as mold inserts, or indirectly, by producing patterns that are, in turn, used in a secondary process to produce the actual tools.

Reverse Engineering. In additive manufacturing, a method of creating a digital representation from a physical object to define its shape, dimensions, and internal and external features.

Sheet Lamination. An additive manufacturing process in which sheets of material are bonded to form an object.

Standard for the Exchange of Product Model Data. The common name for ISO 10303 that "provides a representation of product information, along with the necessary mechanisms and definitions to enable product data to be exchanged. [The standard] applies to the representation of product information, including components and assemblies; the exchange of product data, including storing, transferring, accessing, and archiving."

Stereo-lithography. A vat photo polymerization process used to produce parts from photopolymer materials in a liquid state using one or more lasers to selectively cure to a predetermined thickness and harden the material into shape layer upon layer.

Subtractive Manufacturing. Making objects by removing of material (for example, milling, drilling, grinding, carving, etc.) from a bulk solid to leave a desired shape, as opposed to additive manufacturing.

Surface Model. A mathematical or digital representation of an object as a set of planar or curved surfaces, or both, that may or may not represent a closed volume.

Tool, Tooling. A mold, die, or other device used in various manufacturing and fabricating processes such as plastic injection molding, thermoforming,

blow molding, vacuum casting, die casting, sheet metal stamping, hydroforming, forging, composite lay-up tools, machining and assembly fixtures, etc.

Vat Photo polymerization. An additive manufacturing process in which liquid photopolymer in a vat is selectively cured by light-activated polymerization.

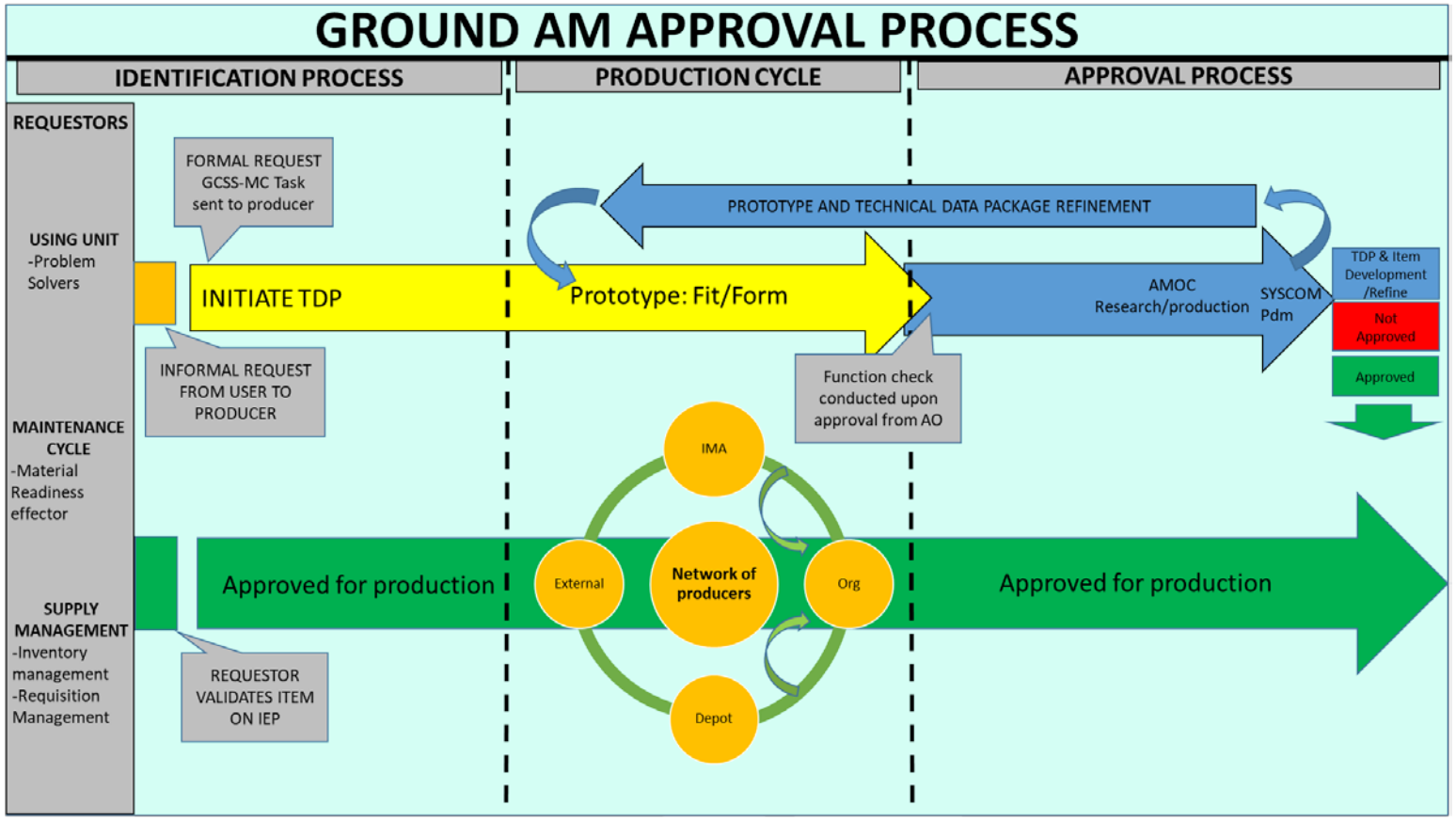
Appendix B

Glossary of Acronyms and Abbreviations

AM	Additive Manufacturing
AMOC	Advanced Manufacturing Operations Cell
AMTC	Additive Manufacturing Training Center
APSR	Accountable Property System of Record
ASL	Aviation Logistic Support Branch
ASM	Advanced Skills Management
AVM	Advanced Manufacturing
CAD	Computer Aided Design
CAGE	Commercial and Government Entity
CNC	Computer Numeric Control
DLA	Defense Logistics Agency
DMA	Depot-Level Maintenance Activity
DPAS	Defense Property Accounting System
DMSMS	Diminishing Manufacturing Sources and Material Shortages
FABLAB	Fabrication Laboratory
FSMAO	Field Supply and Maintenance Analysis Office
GCSS-MC	Global Combat Support System-Marine Corps
ICP	Inventory Control Point
IMRL	Individual Material Readiness List
ITPRAS	Information Technology Procurement Review and Approval System
MCTIMS	Marine Corps Training Information Management System
NAVAIR	Naval Air Systems Command
NIIN	National Item Identification Number
NSN	National Stock Number
OCR	Office of Coordinating Responsibility
OPR	Office of Primary Responsibility
POR	Program of Record
SEMS	Shop Equipment, Machine Shop
SMR Code	Source, Maintenance, and Recoverability Code
SR	Service Request
T&R	Training and Readiness
TACFAB	Tactical Fabrication System
TBA	Table of Basic Allowances
TDP	Technical Data Package
XFAB	Expeditionary Fabrication System

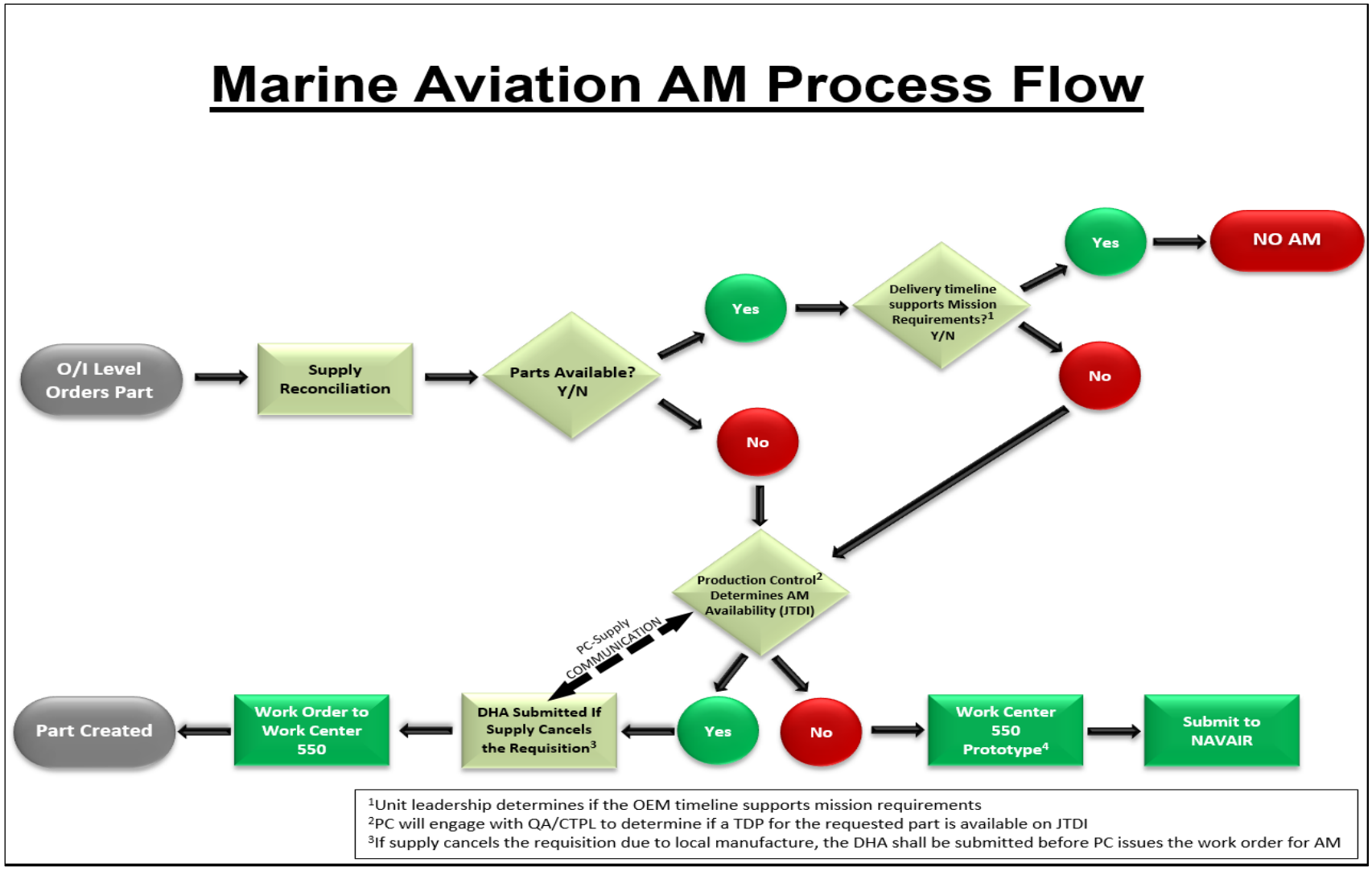
Appendix C

Ground Additive Manufacturing Approval Process



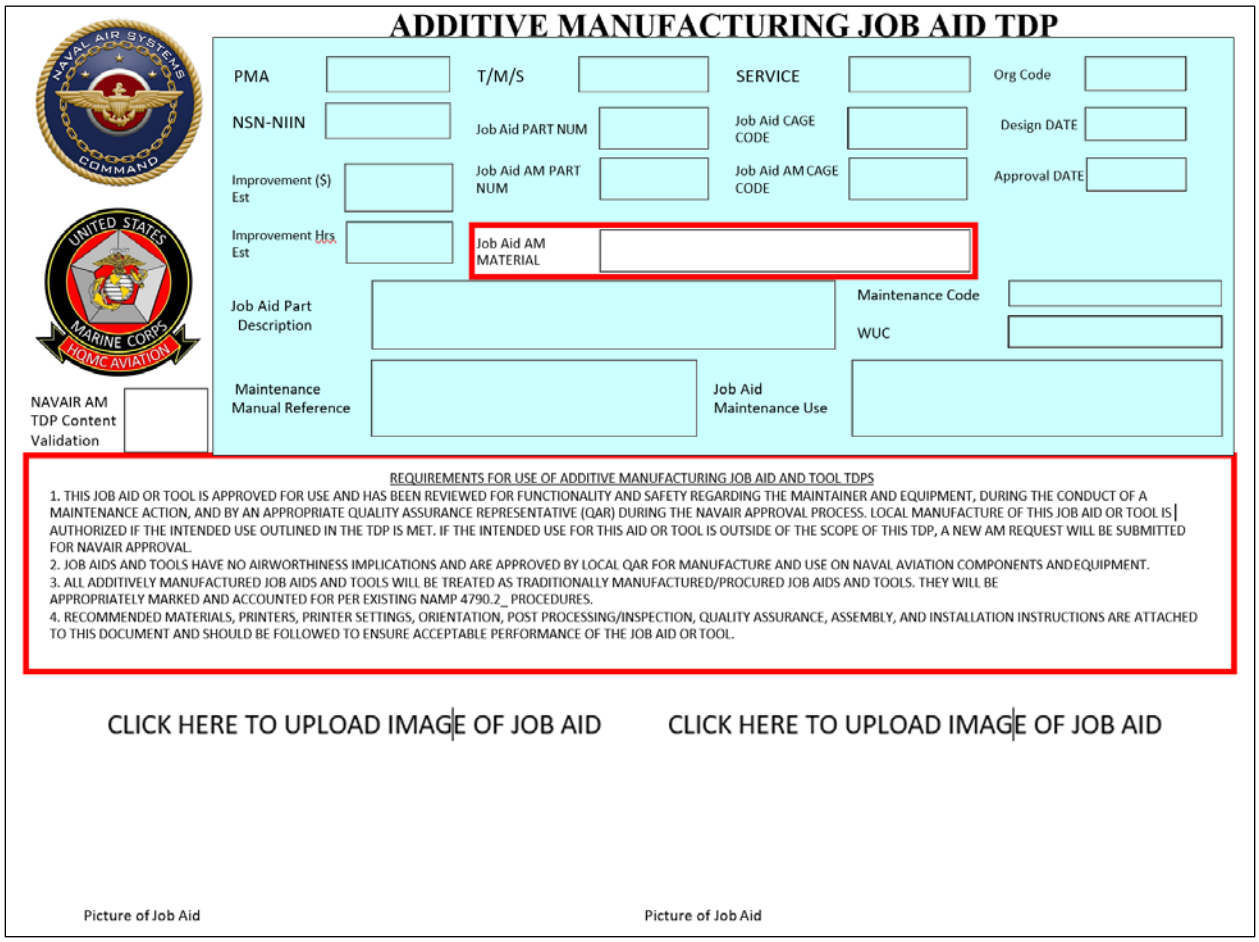
Appendix D

Marine Aviation Process Flow



Appendix E

Naval Aviation AM Job Aid TDP Template



ADDITIVE MANUFACTURING JOB AID TDP

PMA		T/M/S		SERVICE		Org Code	
NSN-NIIN		Job Aid PART NUM		Job Aid CAGE CODE		Design DATE	
Improvement ($) Est		Job Aid AM PART NUM		Job Aid AM CAGE CODE		Approval DATE	
Improvement Hrs Est		Job Aid AM MATERIAL					
Job Aid Part Description				Maintenance Code			
				WUC			
Maintenance Manual Reference				Job Aid Maintenance Use			
NAVAIR AM TDP Content Validation							

REQUIREMENTS FOR USE OF ADDITIVE MANUFACTURING JOB AID AND TOOL TDPS

1. THIS JOB AID OR TOOL IS APPROVED FOR USE AND HAS BEEN REVIEWED FOR FUNCTIONALITY AND SAFETY REGARDING THE MAINTAINER AND EQUIPMENT, DURING THE CONDUCT OF A MAINTENANCE ACTION, AND BY AN APPROPRIATE QUALITY ASSURANCE REPRESENTATIVE (QAR) DURING THE NAVAIR APPROVAL PROCESS. LOCAL MANUFACTURE OF THIS JOB AID OR TOOL IS AUTHORIZED IF THE INTENDED USE OUTLINED IN THE TDP IS MET. IF THE INTENDED USE FOR THIS AID OR TOOL IS OUTSIDE OF THE SCOPE OF THIS TDP, A NEW AM REQUEST WILL BE SUBMITTED FOR NAVAIR APPROVAL.
2. JOB AIDS AND TOOLS HAVE NO AIRWORTHINESS IMPLICATIONS AND ARE APPROVED BY LOCAL QAR FOR MANUFACTURE AND USE ON NAVAL AVIATION COMPONENTS AND EQUIPMENT.
3. ALL ADDITIVELY MANUFACTURED JOB AIDS AND TOOLS WILL BE TREATED AS TRADITIONALLY MANUFACTURED/PROCURED JOB AIDS AND TOOLS. THEY WILL BE APPROPRIATELY MARKED AND ACCOUNTED FOR PER EXISTING NAMP 4790.2_ PROCEDURES.
4. RECOMMENDED MATERIALS, PRINTERS, PRINTER SETTINGS, ORIENTATION, POST PROCESSING/INSPECTION, QUALITY ASSURANCE, ASSEMBLY, AND INSTALLATION INSTRUCTIONS ARE ATTACHED TO THIS DOCUMENT AND SHOULD BE FOLLOWED TO ENSURE ACCEPTABLE PERFORMANCE OF THE JOB AID OR TOOL.

CLICK HERE TO UPLOAD IMAGE OF JOB AID

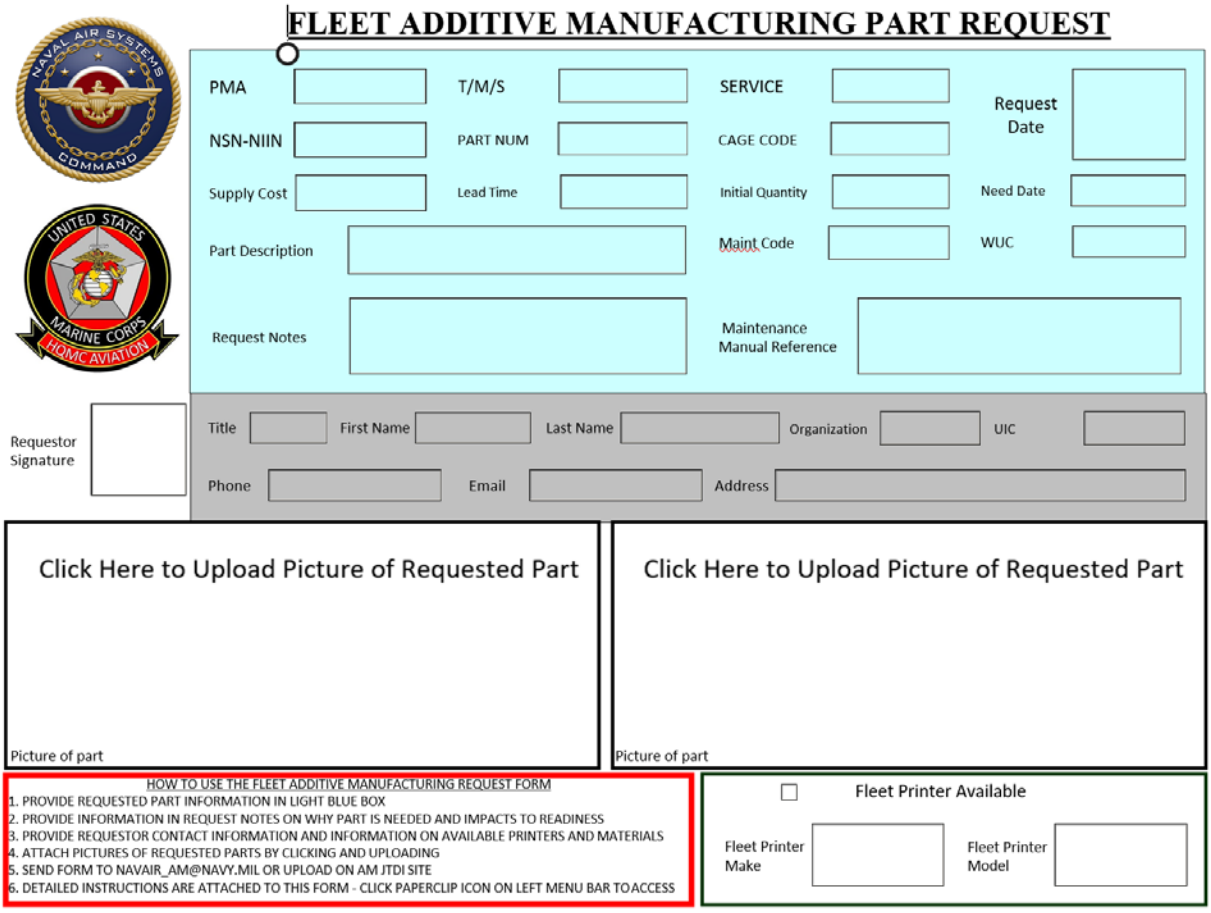
Picture of Job Aid

CLICK HERE TO UPLOAD IMAGE OF JOB AID

Picture of Job Aid

Appendix F

Naval Aviation AM Fleet Part Request Form



FLEET ADDITIVE MANUFACTURING PART REQUEST

PMA | T/M/S | SERVICE | Request Date

NSN-NIIN | PART NUM | CAGE CODE

Supply Cost | Lead Time | Initial Quantity | Need Date

Part Description | Maint Code | WUC

Request Notes | Maintenance Manual Reference

Requestor Signature

Title | First Name | Last Name | Organization | UIC

Phone | Email | Address

Click Here to Upload Picture of Requested Part

Picture of part

Click Here to Upload Picture of Requested Part

Picture of part

HOW TO USE THE FLEET ADDITIVE MANUFACTURING REQUEST FORM

1. PROVIDE REQUESTED PART INFORMATION IN LIGHT BLUE BOX
2. PROVIDE INFORMATION IN REQUEST NOTES ON WHY PART IS NEEDED AND IMPACTS TO READINESS
3. PROVIDE REQUESTOR CONTACT INFORMATION AND INFORMATION ON AVAILABLE PRINTERS AND MATERIALS
4. ATTACH PICTURES OF REQUESTED PARTS BY CLICKING AND UPLOADING
5. SEND FORM TO NAVAIR_AM@NAVY.MIL OR UPLOAD ON AM JTDI SITE
6. DETAILED INSTRUCTIONS ARE ATTACHED TO THIS FORM - CLICK PAPERCLIP ICON ON LEFT MENU BAR TO ACCESS

☐ Fleet Printer Available

Fleet Printer Make | Fleet Printer Model