# Engineering Standards: Best Practices and Emerging Technologies
# NAVSEA Additive Manufacturing Overview

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Additive Manufacturing Technical Warrant Holder

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# NAVSEA Additive Manufacturing Overview

- **Tech Authority**
  - Develop Technical publications for repeatable AM processes
  - Release Guidance describing AM approval processes
  - Collaborate with industrial base
  - ➢ *To Date: Tech Pub for metal AM process; Over 500 Approved parts; 300+ TDPs available to fleet*

DSO valve installed on CVN-75

- **Afloat/Undersea Deployment**
  - Explore how to deploy and integrate advanced/additive manufacturing equipment surface and subsurface
  - Provide in-service engineering support
  - ➢ *Advanced manufacturing equipment installations on 8 ships; 4 submarines deployed with AM; over 4000 parts printed afloat; 50+ Sailors trained*

Component designed with lattice structure

- **Digital Integration**
  - Identify file securing/transiting/storage solutions, including parts repository
  - 'Apollo Lab': Surface fleet able to reach back electronically to CONUS engineering support
  - Explore topology optimization and generative design
  - Development of digital manufacturing enclave to enable networked AM equipment

Example qualification build plate

- **Supply System integration**
  - Incorporate components into logistics databases to enable part provisioning, tracking and 'buy or print' decisions
  - ➢ *96 AM parts have NSNs; initial cost avoidance and lead time metrics generated for afloat components*

# Tech Authority Products

- NAVSEA AM Guidance released August 2018
  - Approval process for AM components
  - Guidelines for use of polymeric materials aboard ship (fire, smoke, and toxicity requirements)
  - Currently being converted into a Tech Manual
- Powder Bed Fusion Technical Publication published – released 21 Jan 2020
- Directed Energy Deposition Technical Publication – released 27 May 2021
- Establishing framework for qualifying material extrusion machines and components
- Develop Technical Data Package for AM components
- Establishing methodology to qualify vendors for metal AM production
- Engage Standard Development Organizations with industry for AM processes

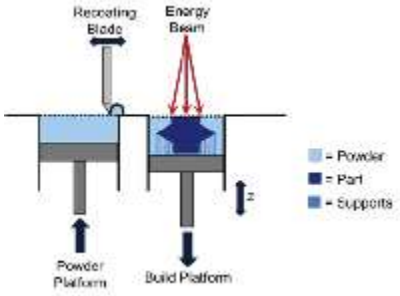
Part Risk Assessment 'Boxes'

Yellow: Part received by NAVSEA, in process of risk assessment

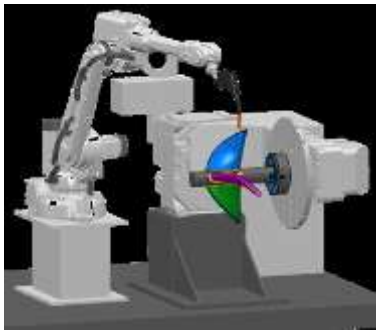
Green: Low criticality, can be approved waterfront or shipboard and installed

Blue: Part requires NAVSEA HQ review and approval

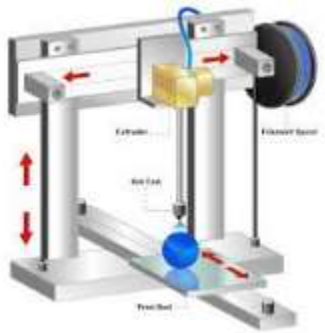
Red: Part cannot or should not be produced via additive manufacturing; will inform S&T strategy



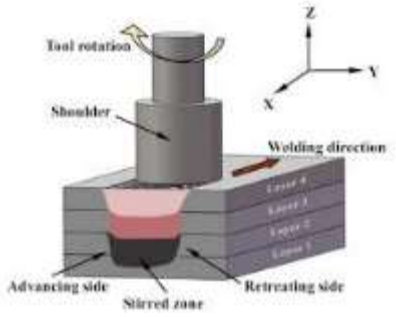

**Powder Bed Fusion Process**



**Directed Energy Deposition Process**



**Material Extrusion**




**Additive Friction Stir**

Ensuring repeatable, reliable production of AM components organically and from industry

# Points of Contact

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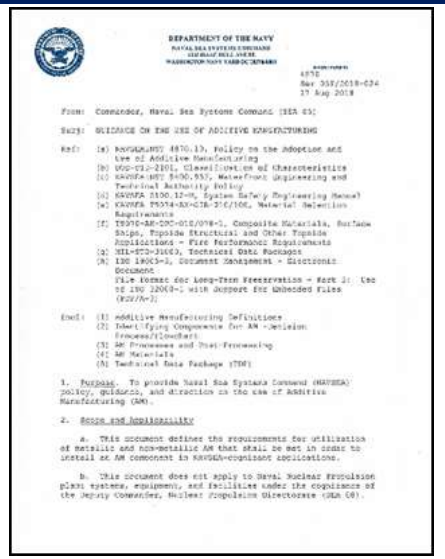
# NAVSEA AM Guidance Overview



- NAVSEA AM Guidance (Ser 05T/2018-024):
  - Decision/Approval Process
  - Definitions
  - AM Procedural Guidance
  - AM Materials (including Fire/Smoke/Toxicity limitations for polymer)
  - Technical Data Package Requirements
- Does:
  - Requirements for shipboard components
  - Submittal/approval process for AM components installed shipboard
  - Applicable for all vessels
    - EXCEPTION: Submarines currently only have one material approved for use (PETG). Installation of AM components on subs still require DFS.
  - Fire/Smoke/Toxicity allowances for polymer materials
  - Requirements for incorporation of polymer materials shipboard
  - Metallic material requirements/considerations
- Does NOT:
  - Apply to Naval Nuclear Propulsion plant systems, equipment and facilities under cognizance of Naval Reactors (SEA08)
  - Apply to Strategic Weapons Systems and Attach Weapons Systems under cognizance of Strategic Systems Programs
  - Provide guidance for AM equipment installation shipboard

# Technical Publications Overview

- Scope and Applicability: These documents provide procedure qualification requirements, part verification requirements, and production requirements for fabricating parts using specific additive manufacturing processes.
  - Establishes *local* material properties for specific process and material combinations
- General Requirements and Test Reports
  - Qualification Levels
    - General: Essential elements for the process shall be incorporated into the procedures IAW tech pub requirements.
    - Level 1: Initial qualification of procedures for the fabrication of material and parts by any activity.
    - Level 2: Intended to permit procedure approval for a variation in a procedure that has already been qualified by Level 1. Requires one part verification build for an intended variation change to the procedure.
- Process Qualification
- Procedure qualification test report
- Production conformance evaluation plan
- Quality assurance and process control test plan
- Evaluation and requalification
- Acquisition