Alpha Workshop for ABS Guide: Additive Manufacturing (AM)

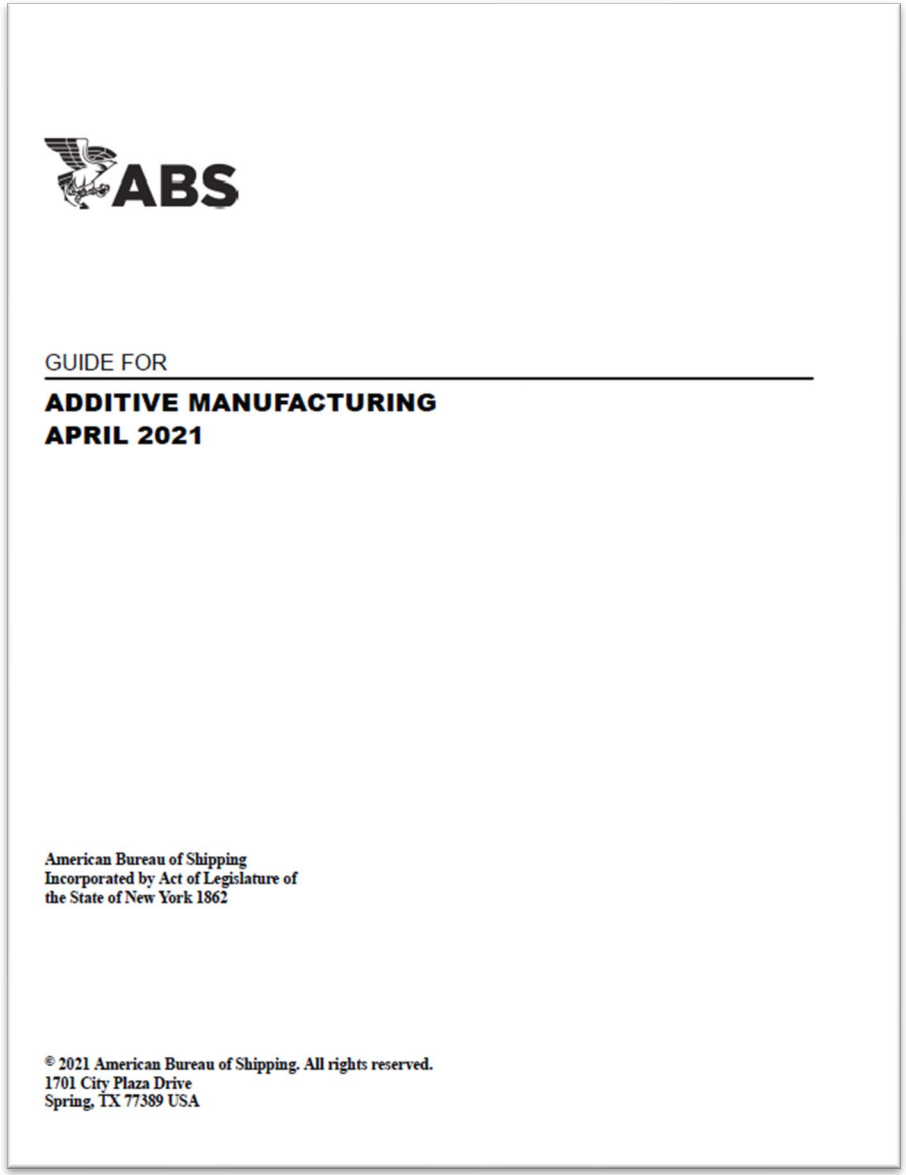
2021

Opening Remarks

- ABS Advisory – Published in 2017
- ABS Guidance Notes – Published in 2018
- ABS Approved Crane Hook - Installed in 2019
- ABS Guide – Published in April 2021

Outline

- Introduction
- Standardization
- Approval for AM Facility
- Approval for AM Part
- AM Activities in ABS
- Summary


ABS

GUIDE FOR

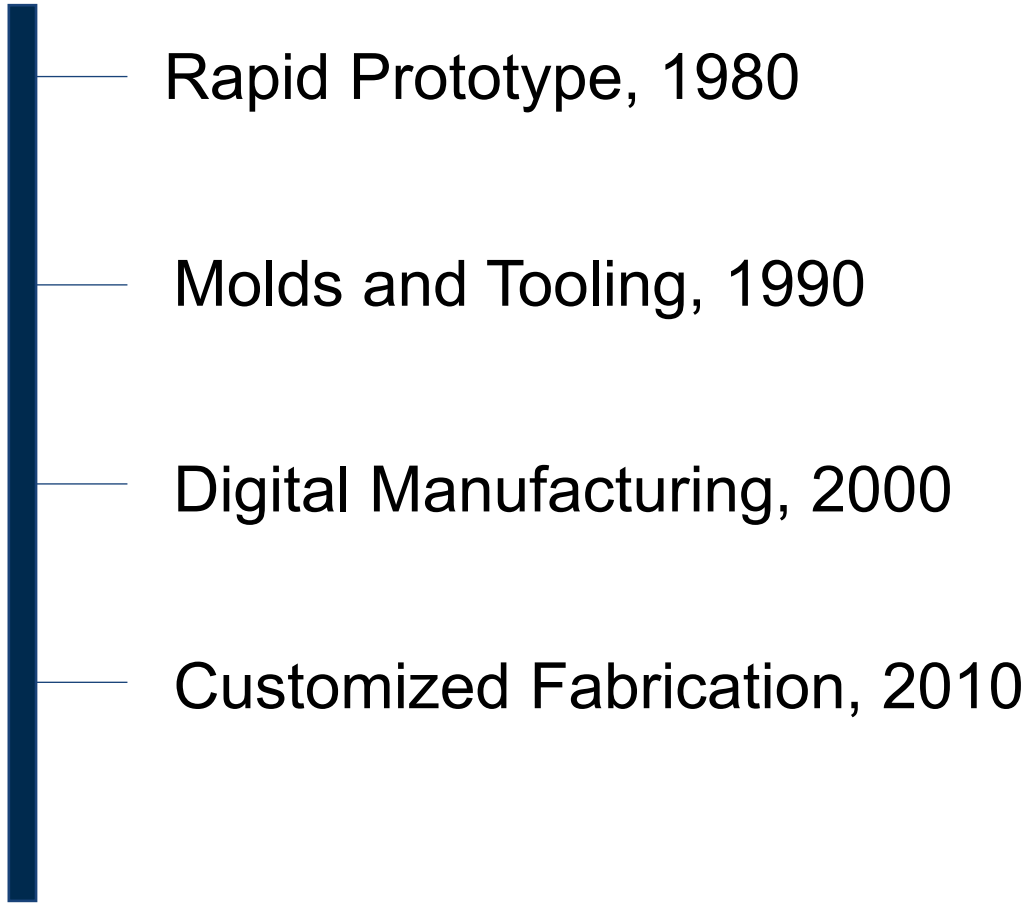
ADDITIVE MANUFACTURING
APRIL 2021

American Bureau of Shipping
Incorporated by Act of Legislature of
the State of New York 1862

1701 City Plaza Drive
Spring, TX 77389 USA

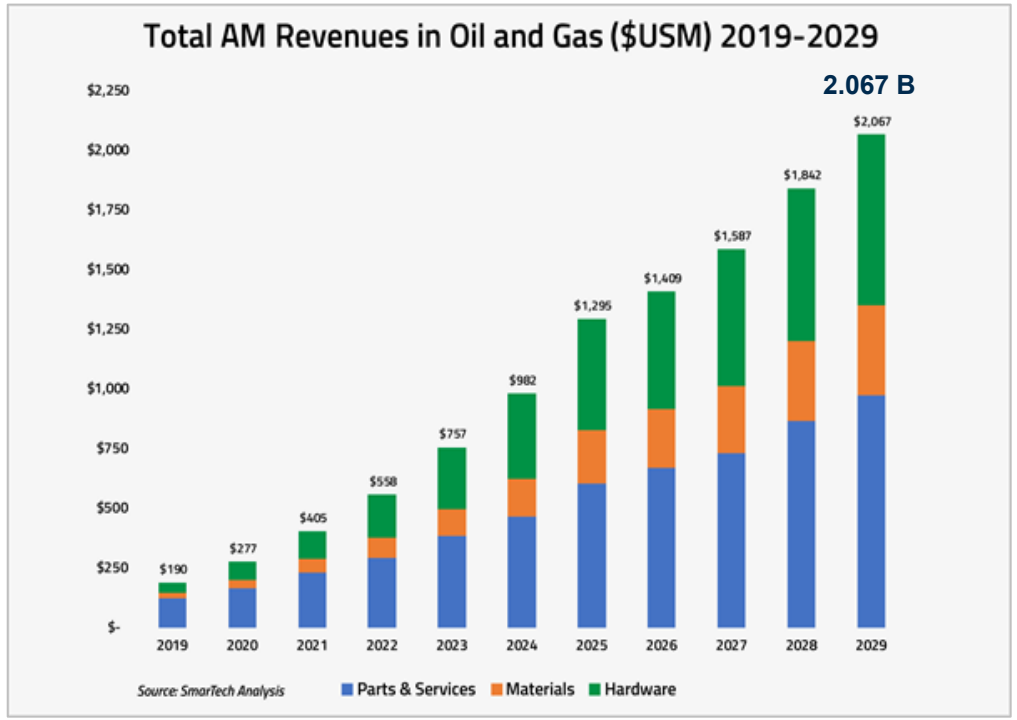
Introduction

- AM History
  - Prototype to end-use
  - Non-metallic to metallic
  - Desktop to computer numerical control (CNC) machine or robotic arm
- Feasible to implement AM technology for Marine and Offshore



AM Value

- Market Forecast in Oil and Gas



Source: Grandview Research

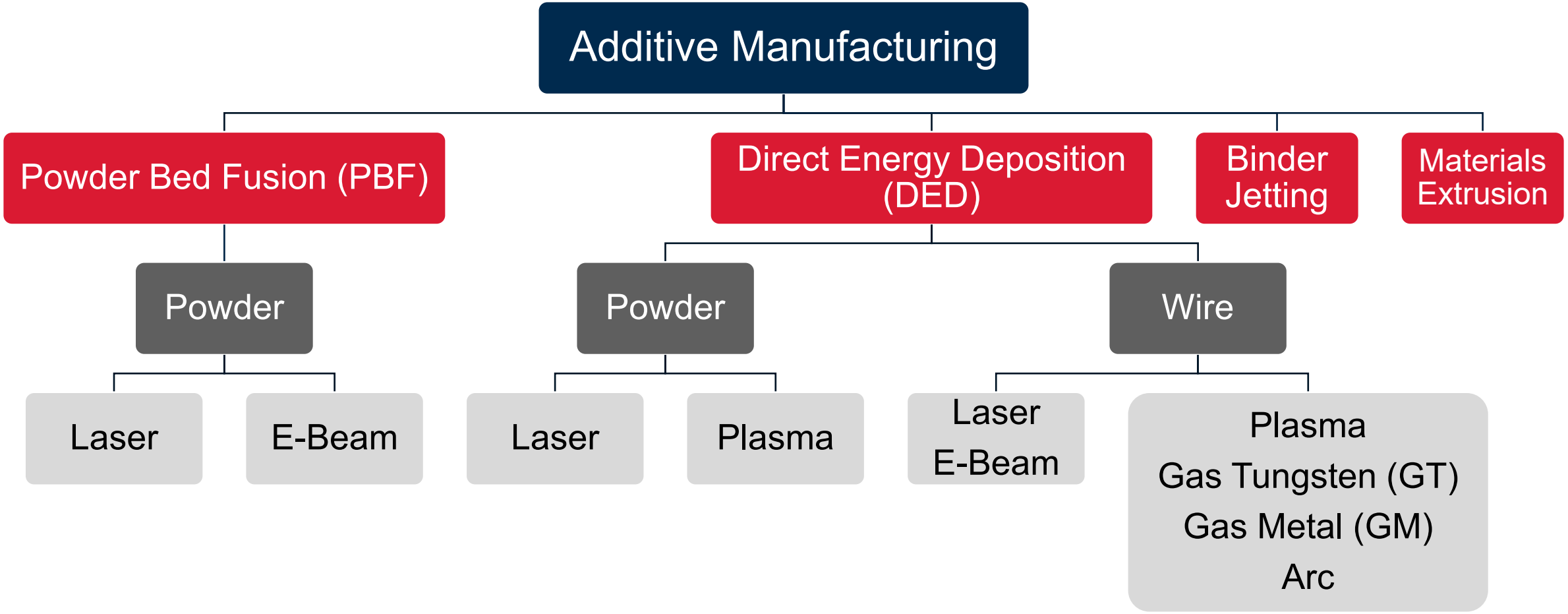
- Supply Chain
- More Flexibility in Design
- Small Batch Production
- Hybrid Metal AM Process

AM vs. Traditional Manufacturing

Traditional Manufacturing	Additive Manufacturing (AM)

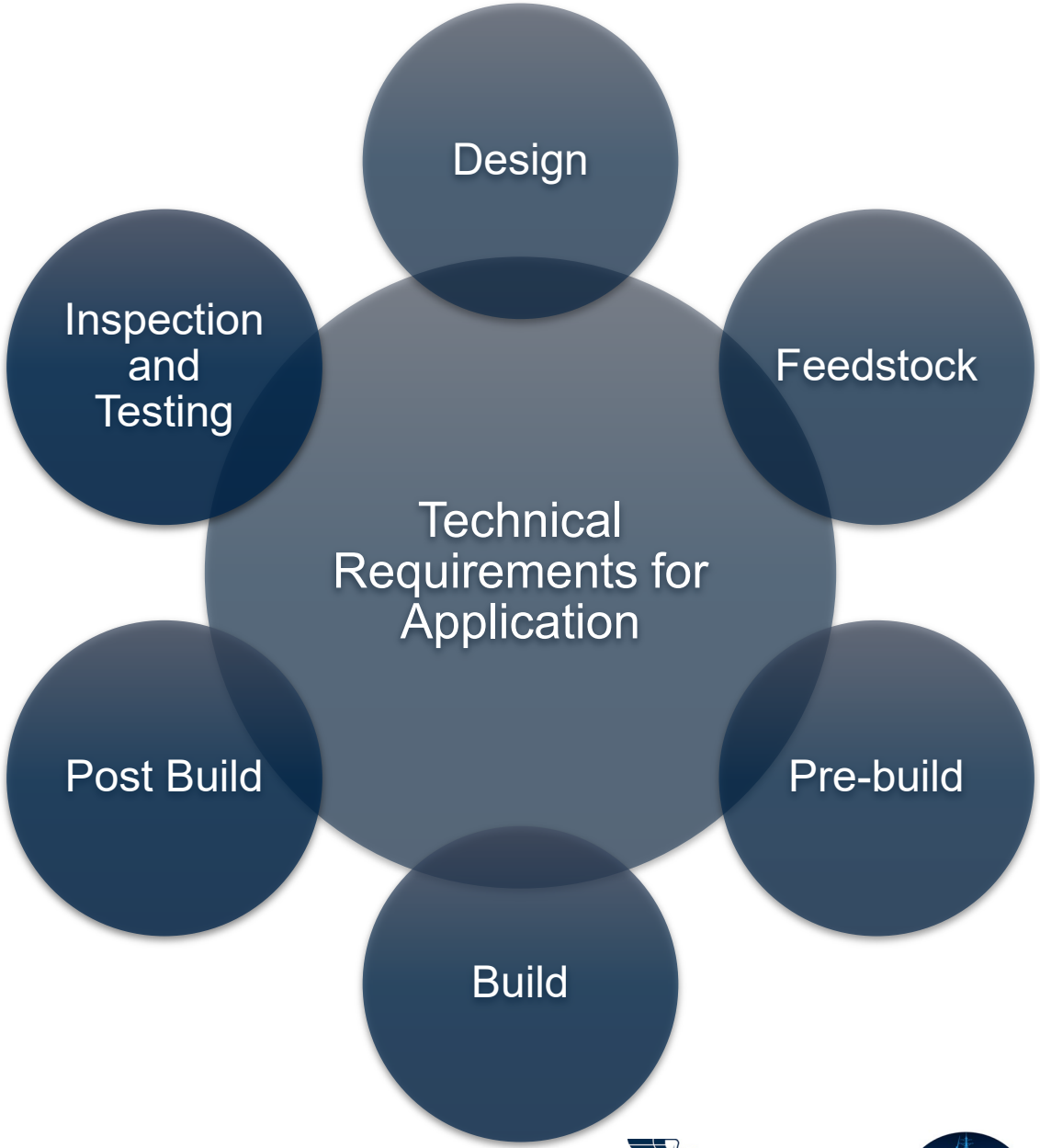
• Materials Manufacturing
  - Rolling, Casting, Forging, Heat Treatment etc.
  - To meet mechanical property requirements
• Machining
  - Cutting, Turning, Milling, Grinding, Drilling etc.
  - To meet dimension and special features
• Connecting
  - Welding, Brazing, Soldering, Fastening
  - To join or connect multi-pieces
	• Integrated process of materials manufacturing, machining and welding
	• Fused/Joined materials to make parts from sliced 3D solid model data
	• Built layer by layer
	• Digital controlled by machine software and hardware

AM Processes

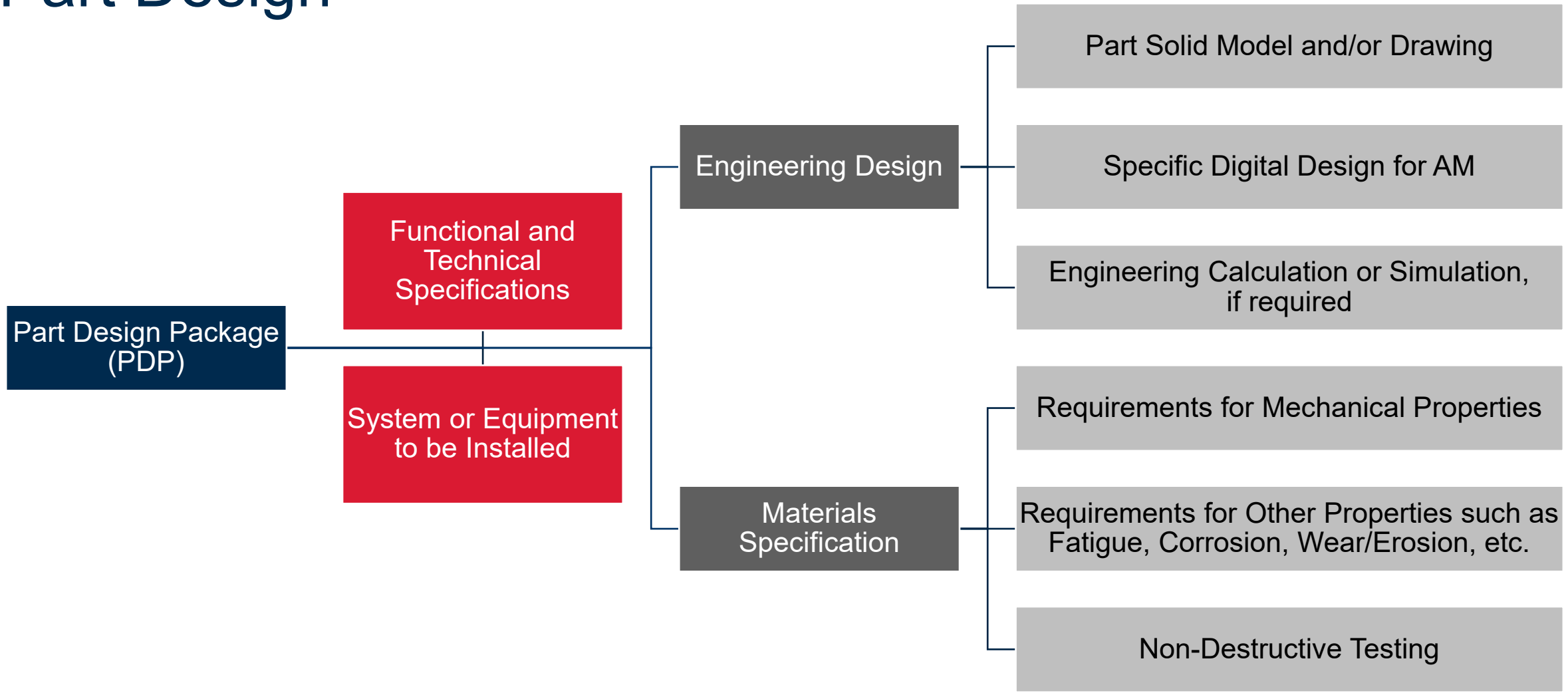


Standardization

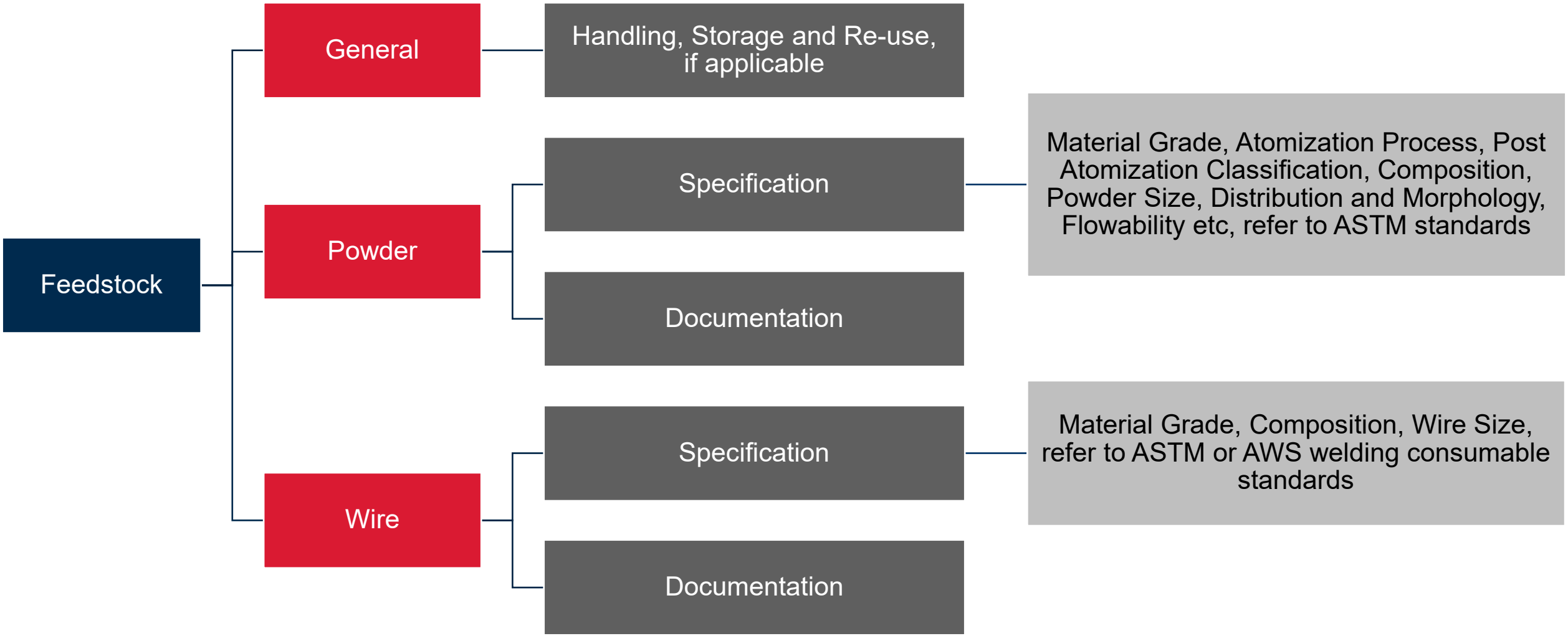
- Specifications with revision
- Documentation
- Production



Part Design

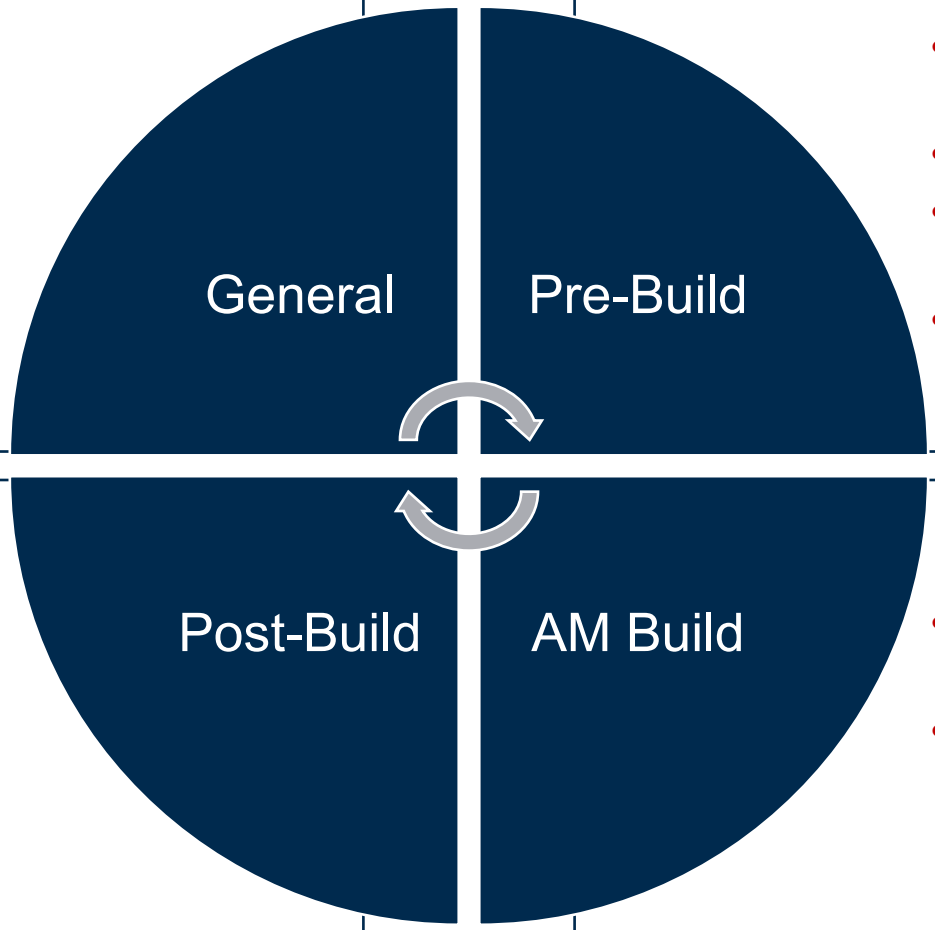

Part Design Package (PDP)
Functional and Technical Specifications
System or Equipment to be Installed
Engineering Design
Part Solid Model and/or Drawing
Specific Digital Design for AM
Engineering Calculation or Simulation, if required
Materials Specification
Requirements for Mechanical Properties
Requirements for Other Properties such as Fatigue, Corrosion, Wear/Erosion, etc.
Non-Destructive Testing

Feedstock


Feedstock
General
Handling, Storage and Re-use, if applicable
Powder
Specification
Material Grade, Atomization Process, Post Atomization Classification, Composition, Powder Size, Distribution and Morphology, Flowability etc, refer to ASTM standards
Documentation
Wire
Specification
Material Grade, Composition, Wire Size, refer to ASTM or AWS welding consumable standards
Documentation

AM Manufacturing Process

- Machine (Hardware and Software)
- Procedure
- Operator



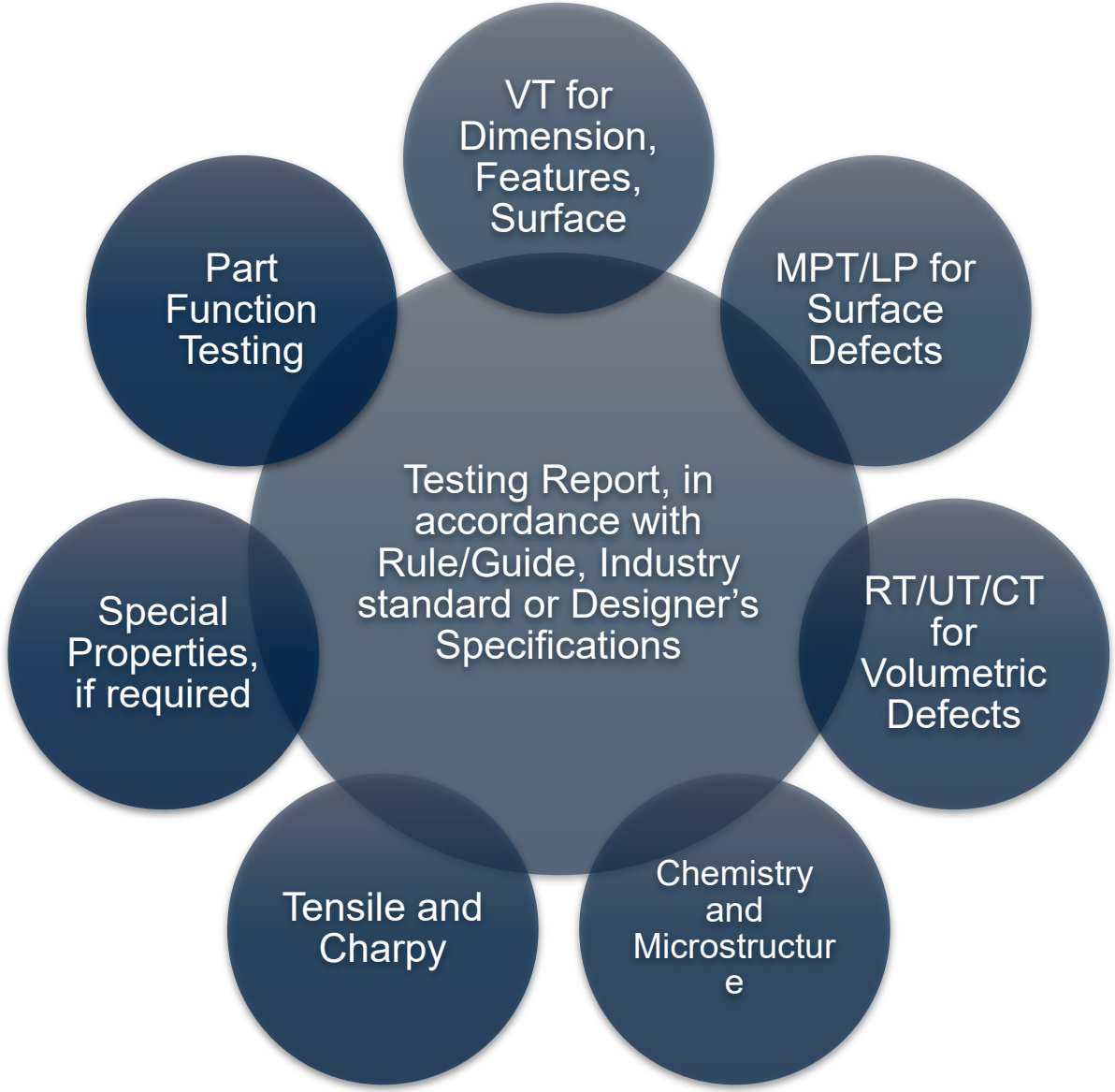
- Part Location and Orientation
- Test Coupon Location and Orientation
- Machining allowances
- Others such as support, infill, contour, transition etc.
- Digital Build Model, STL, 3MF etc.

- Part and Support Removal
- Stress Relief
- Hot Isotropic Pressure (HIP)
- Other Heat Treatment
- Surface or Feature Finish

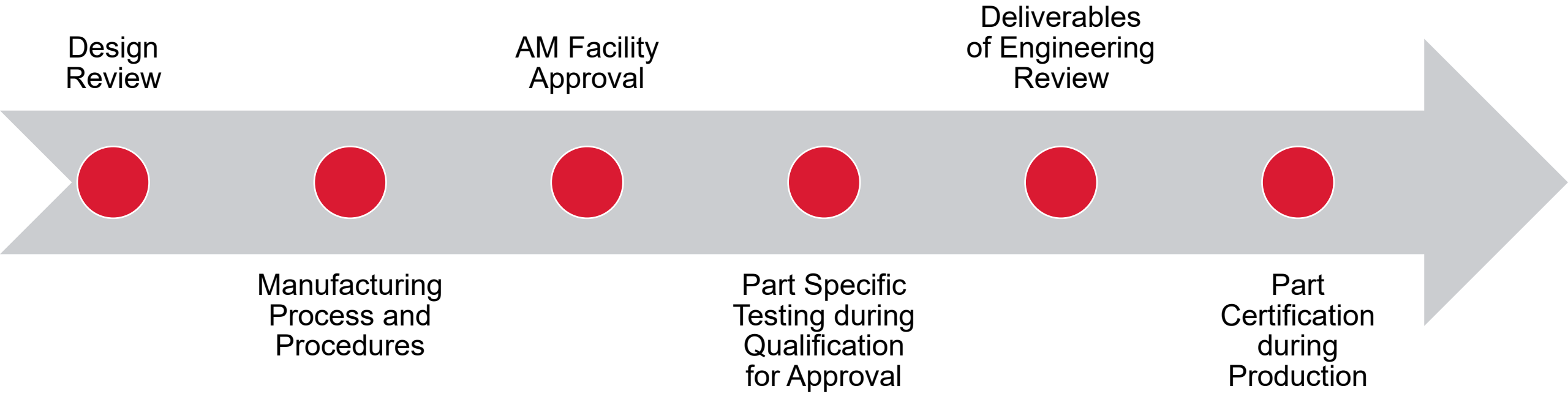
- Heat Input: Beam/Arc Power and Size
- Heat History: Scan Pattern, Travel Speed, Hatch Overlap and Distance, Layer Thickness, Edge and Surface Control
- Build Environment

Inspection and Testing

- ABS Rules for Materials and Welding and the applicable sections enclosed in other ABS Rules for application.
- ASTM A751 for Chemical Analysis
- ASTM A370 for Mechanical Testing
- ASTM E8 for Tensile Testing
- ASTM E23 for Notched Bar Impact Testing
- ASTM E10 for Hardness
- ABS Guide for Non-Destructive Inspection or ASTM WK68731
- Other recognized industry standards in accordance with ISO/ASTM

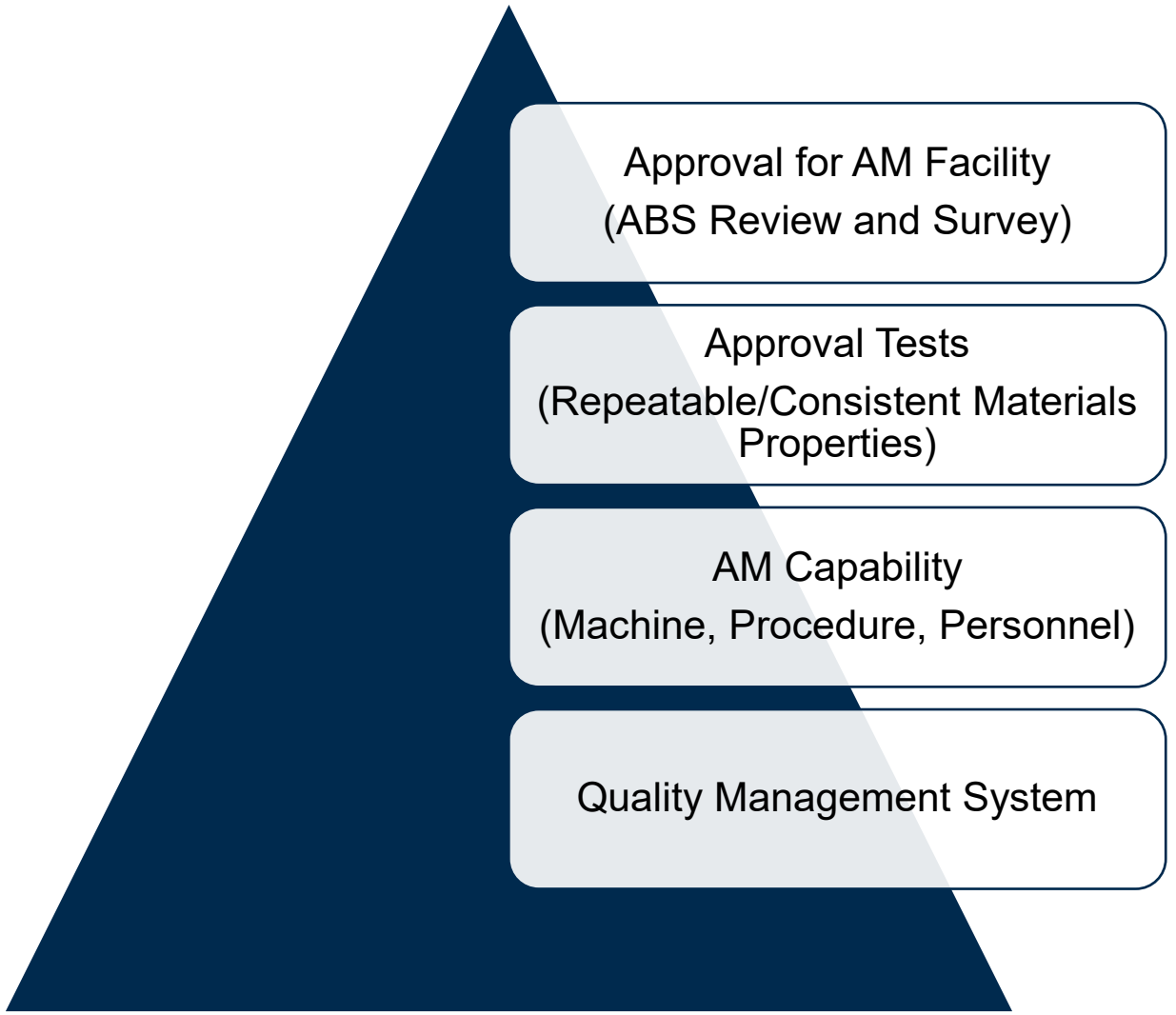


ABS Approval and Certification Process



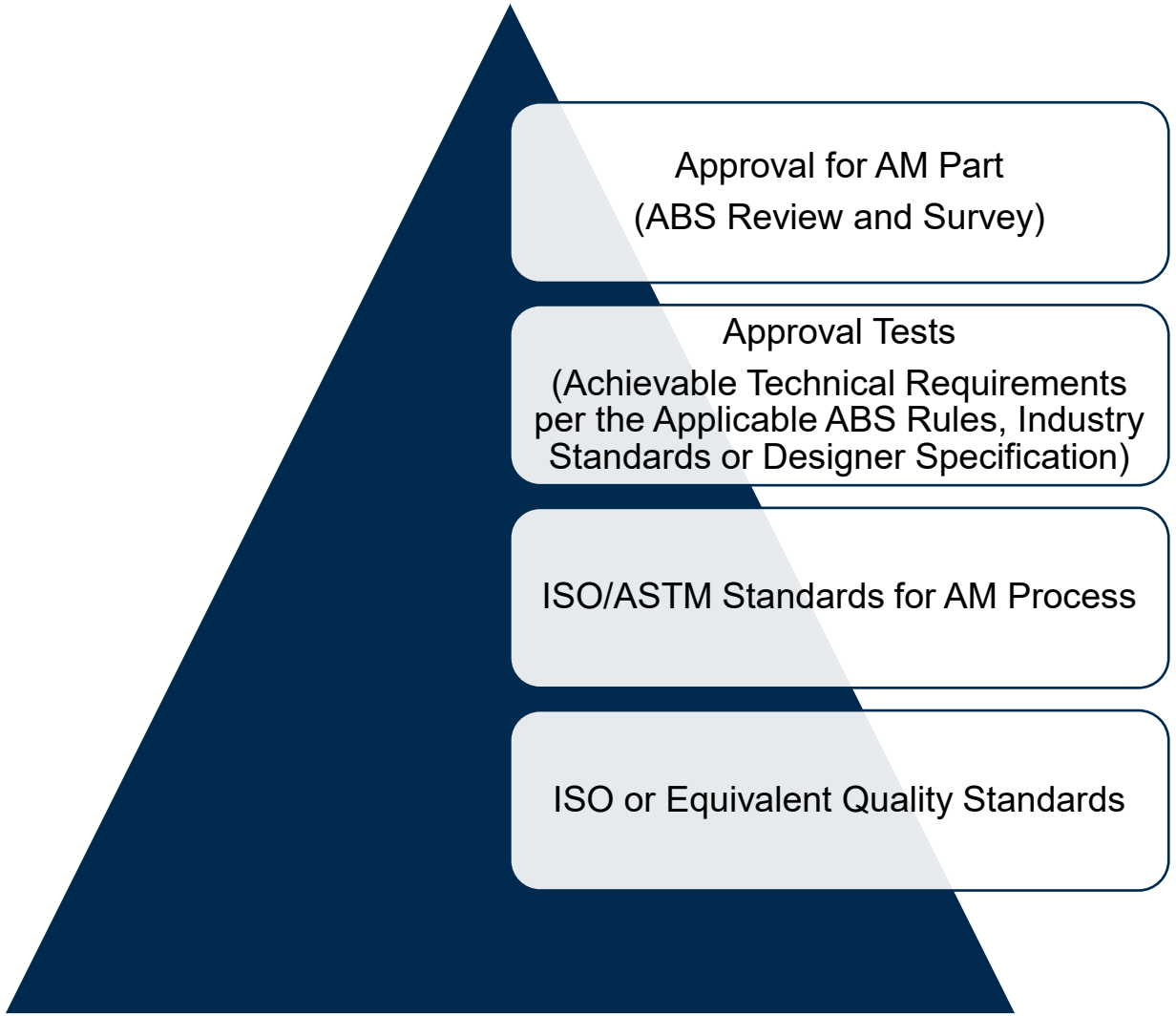
Approval for AM Facility

- Quality Management System
- AM Capability
- Machine, Procedure, Operator Qualification
- Approval Tests
- Submittals
- Approval for AM Facility
- Range of Approval

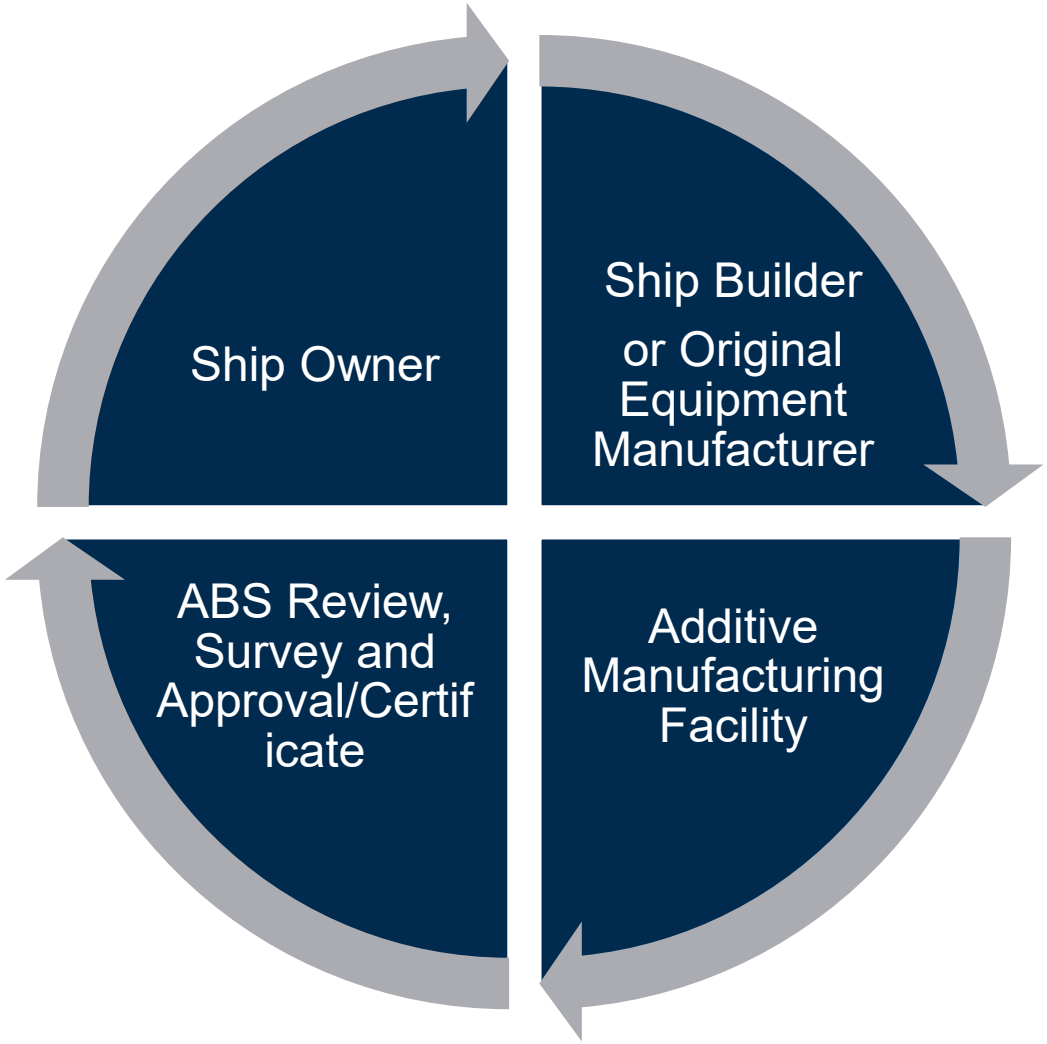


Approval for AM Part

- ISO Standards
- ASTM Standards for AM Process
- Approval Tests
- Submittals
- Approval for AM Part
- Range of Approval
- Fabrication Plan



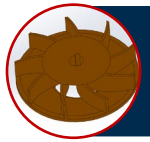
ABS Review and Survey



- Adoption and Expansion by Collaboration
- Input by Ship Builder or Original Equipment Manufacturer
- Pre-building, Building, Post-building, Inspection and Testing by Additive Manufacturing Facility
- Design Review, Manufacturer Survey and Approval by ABS
- On-Board Performance and Close-Loop Feedback for Continuous Improvement

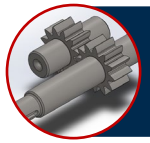
AM Activities in ABS

- Small Crane Hook with Design Load of 80 Metric Tons
- 4 Prong Crane Hook with Design Load of 250 Metric Tons
- Pump Impeller



- Pump Flexible Coupling

- Pump Gear Sets



- Generator Air Ejector Nozzle

Summary

- AM process is standardized using Specification. The applied parameters are controlled, monitored and documented.
- AM facility can be qualified and approved based upon the desired materials properties support by the history data in manufactured materials or parts.
- AM part can be qualified and approved based upon the desired requirements for part engineering design and functionality.
- Class parts can be certified based upon satisfactory completion of required approval of AM facility and AM part, as well as agreed fabrication plan and witness. Certification is optional for non-class parts.
- Qualification and Certification follow ABS Rules/Guides for class parts and industry standards or designer's specifications for non-class parts.

Closing Remarks

- Update ABS Guide for Polymer and Polymer Composite
- Expand Adoption of AM Technology in Spare Parts
- Improve Capabilities and Efficiency of DED Process for Large Structure
- Explore Non-Critical Marine and Offshore Applications of Low-Cost AM Processes such as Binder Jetting or Materials Extrusion Processes

Thank You

www.eagle.org