



Additive Manufacturing at MSFC

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- The lab has experience with 30 different systems over the last 30 years
- NASA AM Objectives
 - Decrease production lead time & costs
 - Develop and Maintain Flight Certification Standards
 - Process development and characterization
 - Share knowledge and data in pursuit of smart vendor base & ensure agency remains a smart buyer
 - Design optimized components & test at relevant conditions
 - Appropriate Application
 - High complexity & difficult to manufacture
 - Low production rate
 - Long lead time & high cost





Concept Laser Xline 1000R
(Retiring Soon)

In718

Build Volume: 630 x 400 x 500 mm



Velo3D Sapphire (Summer 2022)

In718

Build Volume: 315mm Ø x 400mm z



EOS M290 (Two Machines)

HR1, JBK75 Dev

Build Volume: 250 x 250 x 325 mm



EOS M100

Various Materials

Build Volume: 100 Ø x 95 mm z



Concept Laser Xline 2000R

In718

Build Volume: 400 x 800 x 500 mm



Concept Laser M1

In625/In718

Build Volume: 250 mm³



Concept Laser M2

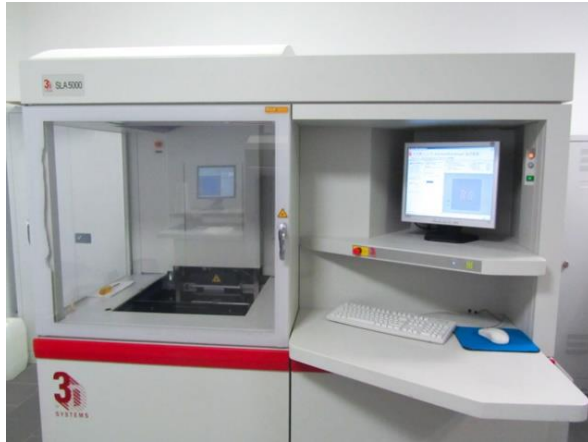
GRCop-42

Build Volume: 245 x 245 x 350 mm



DM3D Directed Energy Deposition

Various Materials



SLA 5000

Somos Watershed 11122 XC
Build Volume: 20 x 20 x 20 in



Stratasys Fortus 900mc

ABS, PC, Ultem 9085
Build Volume: 36 x 24 x 36 in



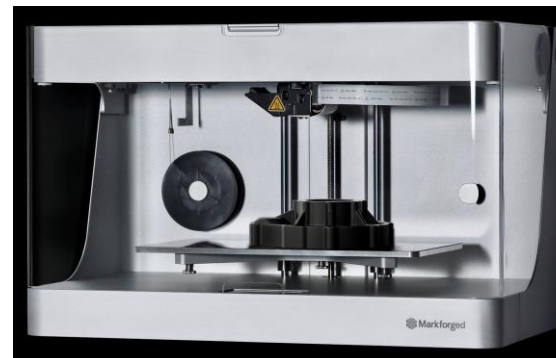
AON M2+ (August 2022)

PEEK, PEKK, Ultem, PC, ABS
Build Volume: 450 x 450 x 565 mm



SLA Viper

DMX Somos
Build Volume: 10 x 10 x 10 in



Markforged Mark II

Onyx, Nylon, Carbon Fiber, Glass Fiber, Kevlar
Build Volume: 320 x 132 x 154 mm

Additive Manufacturing Control Plan

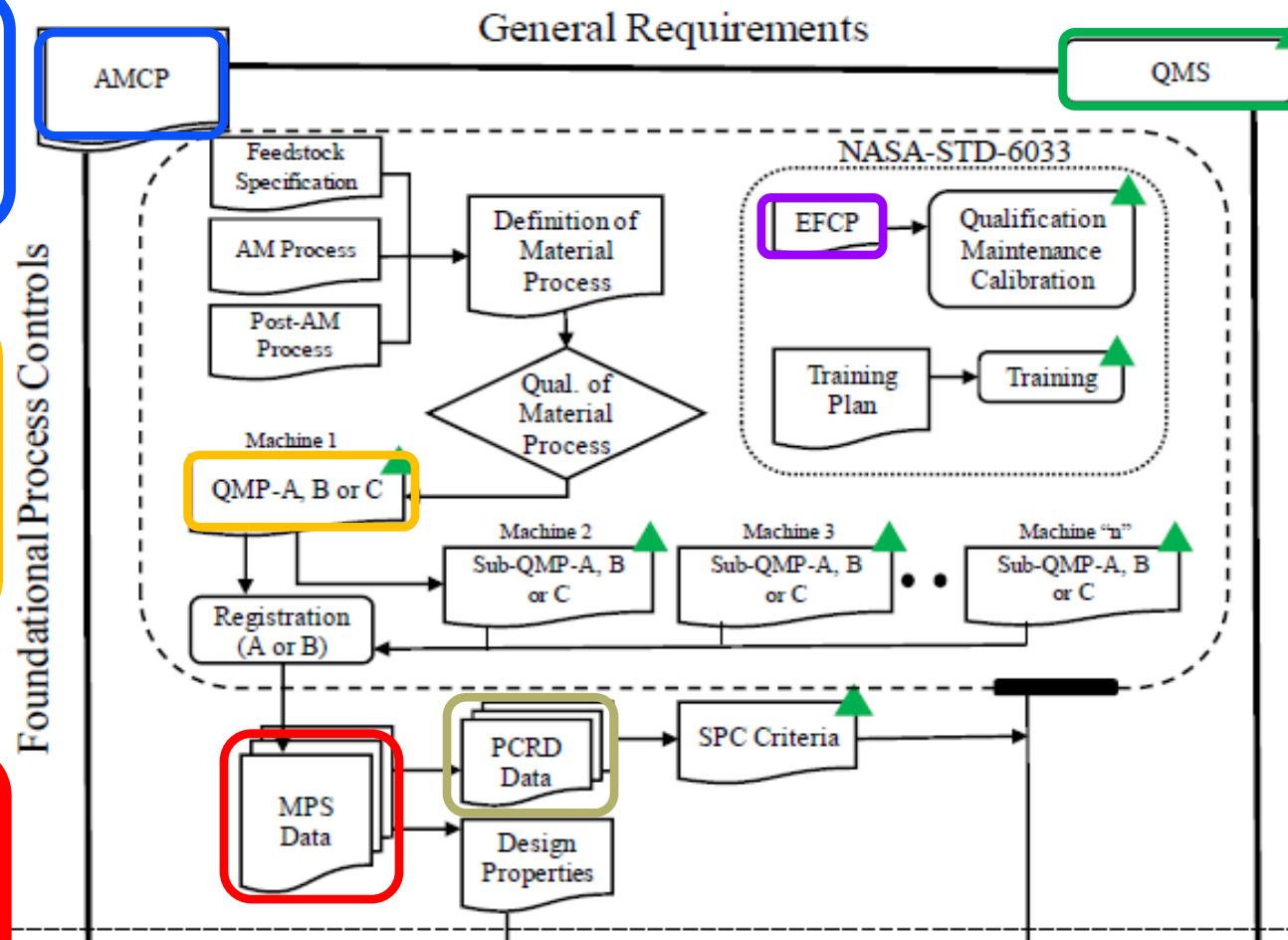
- Document describing the means of conformance, method of implementation, and tailoring rationale for each requirement in NASA-STD-6030
- Complimented by a robust QMS

Qualified Material Process

- Document containing a record of process controls providing assurance of process repeatability for the foundational elements of AM (i.e. feedstock material quality, machine controls, and post-processing controls)
- Required for each machine/material combination

Material Property Suite

- Collection of AM material property information that includes material test data, material allowables and associated design values, and criteria needed to implement and maintain SPC for the AM process
- Specific to one material and condition



From NASA-STD-6030: Additive Manufacturing Requirements for Spaceflight Systems

Quality Management System

- System that documents processes, procedures, and responsibilities for achieving quality products
- Complimented by a robust AMCP

Equipment & Facility Control Plan

- Document that controls the AM equipment, associated facilities, and training of personnel involved with producing AM hardware.
- NASA-STD-6033 governs EFCP requirements and is a component of NASA-STD-6030

Process Control Reference Distribution

- Statistical model used to create acceptance criteria for evaluation of witness specimens used to monitor the AM process (i.e. For metallic AM builds, 4 PCRDs are defined for each MPS: UTS, yield strength, elongation, and fatigue life)
- The choice of PCRDs may change with AM process and material



MSFC Collaboration with MELD



- Evaluation of MELD process maturity
- Produce demonstration hardware
- Conduct mechanical and microstructural evaluation
- Assess NASA-STD-6030 applicability to MELD process
 - Understand how to comply with the standard as currently written
 - Tailor the standard as necessary to apply to a novel process, such as MELD
 - Develop roadmap for next steps towards qualification



Questions?

