Savannah River National Laboratory®

ASME Criteria for Powder Bed Fusion Additive Manufacturing

ASME Special Committee on Additive Manufacturing

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America Makes and ASMC Design for Additive Manufacturing Workshop
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ASME Criteria for Powder Bed Fusion Additive Manufacturing

- **What is Additive Manufacturing**
- **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.
- **Subtractive Manufacturing** - making objects by removing material (for example, milling, drilling, grinding, etc.) from a bulk solid to leave a desired shape.

Subtractive

Additive

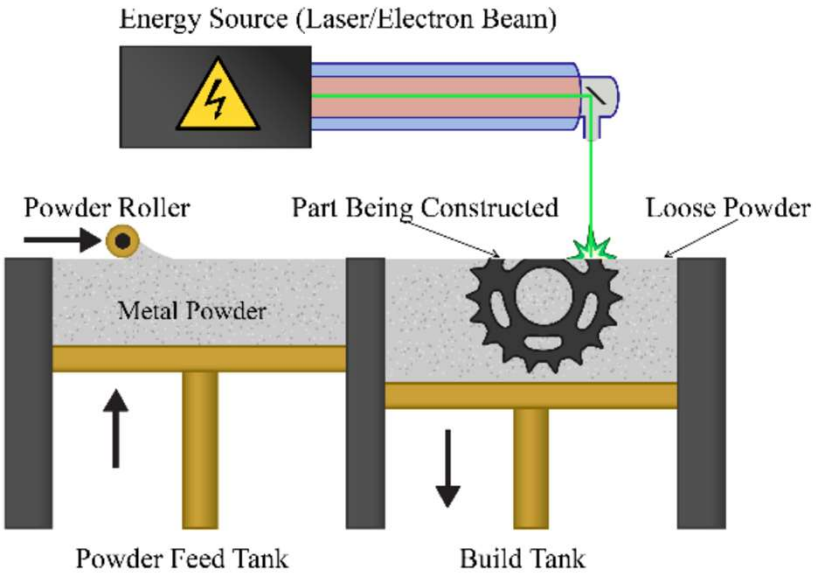
Additive + Subtractive

Application will require additive joined to non-additive

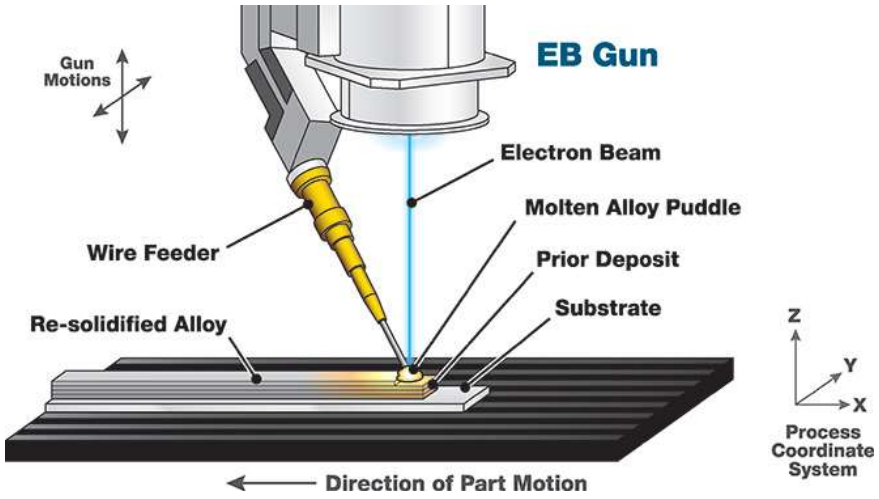
ASME Criteria for Powder Bed Fusion Additive Manufacturing

- **Additive Manufacturing Technologies**

Powder Bed Fusion



Direct Energy Deposition



ASME Criteria for Powder Bed Fusion Additive Manufacturing

- **The ASME Special Committee has produced a final draft document providing Criteria for Pressure Retaining Metallic Components Using Additive Manufacturing.**

- **The document is intended to provide criteria on the materials, design, fabrication, examination, inspection, testing and quality control essential to be addressed in any proposed standard for the construction of metallic pressure retaining equipment using powder bed fusion additive manufacturing.**
- **The additive manufacturing criteria document addresses the follow areas.**

- **Scope**
- **Additive Manufacturing Specification**
- **Materials**
- **Thermal Treatment**
- **Powder Requirements**
- **Additive Manufacturing Design Requirements**
- **Additive Manufacturing Procedure**
- **Additive Manufacturing Procedure Qualification**
- **Qualification Testing of Additive Manufactured Components**
- **Production Builds**
- **Chemistry Testing**
- **Mechanical Property Testing**
- **Metallographic Evaluation**
- **Referenced Standards**
- **Definitions**
- **Records**
- **Quality Program**

ASME Criteria for Powder Bed Fusion Additive Manufacturing

- **Scope**
  - These criteria address the construction of pressure retaining equipment using the Additive Manufacturing (AM) Powder Bed Fusion process using both Laser and Electron Beam energy sources.
  - Hybrid construction incorporating AM components joined (Welded or Brazed) to non-AM components is acceptable. Additive manufactured components joined to other AM components or non-AM components shall follow the requirements for the applicable ASME Construction Code or Standard.
  - The pressure design for components shall follow the requirements of the applicable ASME Construction Code or Standard.
  - The maximum design temperature shall be at least 50°F (25° C) colder than the temperature where time-dependent material properties begin to govern for the equivalent wrought ASME material specification, as indicated in ASME Section II, Part D [15.1].
  - The minimum design temperature shall follow the requirements for the applicable ASME Construction Code or Standard.

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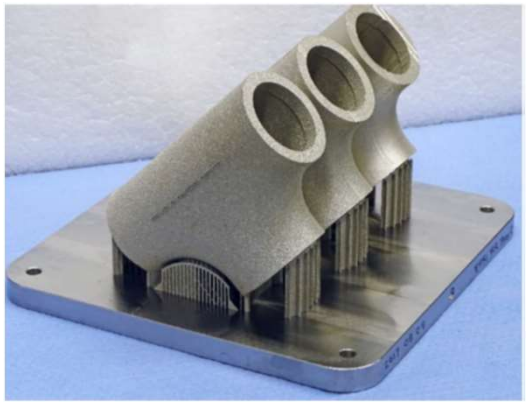
- **Design**
  - In addition to the design requirements of the ASME Construction Code or Standard the following design requirements apply for components produced using the powder bed fusion AM process.
  - Any material produced during the AM build that is specified as cosmetic material shall not be credited as load bearing material in the stress analysis.
  - Fatigue critical surfaces shall be designed to be accessible for liquid penetrant examination.
  - Surfaces interfacing with sacrificial supports shall be fully accessible for removal of supports and for liquid penetrant examination.
  - The effect of any support that will not be removed following the AM build shall be included in the stress analysis.

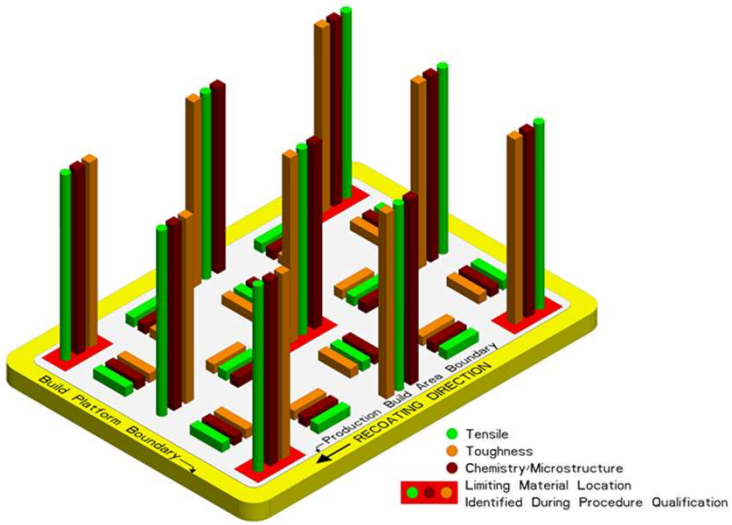


Sacrificial Supports
Courtesy Rolls- Royce

Permanent Supports

ASME Criteria for Powder Bed Fusion Additive Manufacturing

- **Additive Manufacturing Procedure**
  - Additive Manufacturing Procedure
    - The Additive Manufacturer shall prepare an Additive Manufacturing Procedure.
    - The AM Procedure shall address applicable process variables.
    - The Additive Manufacturer shall complete sufficient qualification builds and produce sufficient material qualification specimens to support a 95% confidence that 99% of the produced material is in accordance the ASME material specification.
    - The Additive Manufacturer shall identify the locations of limiting material conditions for each energy source.



Material Qualification Specimens for Additive Manufacturing Procedure Qualification

ASME Criteria for Powder Bed Fusion Additive Manufacturing

- **Path Forward**
  - The intent is to publish the ASME Criteria for Powder Bed Fusion Additive Manufacturing as a Pressure Technology Book (PTB) for use as a reference document for additive manufacturing Code Cases or incorporation of additive manufacturing into construction codes.
  - ASME has submitted a Project Initiation Notification with ANSI stating that they will develop a standard for additively manufactured pressure equipment.
  - Section V is developing a new article for the 2021 edition for computed tomography.
  - SRNL has started a collaborative project with the University of Michigan to evaluate fatigue design criteria for additively manufactured pressure equipment .

QUESTIONS