Industry Perspectives on Qual & Cert

America Makes and ANSI Additive Manufacturing Standardization Collaborative (AMSC)

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AMSC Mission and Goals

- Launched in March 2016
- Drive coordinated standards activity among AM Standards Developing Organizations (SDOs)
  - Avoid duplication of effort
  - Encourage liaisons between SDOs
  - Provide subject matter experts to help SDOs develop the standards
  - Better inform decision-making on resource allocation for standards participation and R&D needs
- Clarify the current and desired future standardization landscape
- Establish a common framework of AM standards and specs
- AMSC does not develop standards

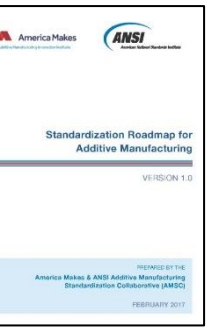
AMSC PURPOSE

To coordinate and accelerate the development of industry-wide additive manufacturing (AM) standards and specifications, consistent with stakeholder needs, and thereby facilitate the growth of the additive manufacturing industry

Evolution of Roadmap

March 2016

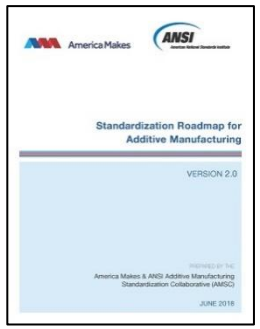
Additive Manufacturing Standards Collaborative (AMSC) formed



Feb 2017

Roadmap v1 Published

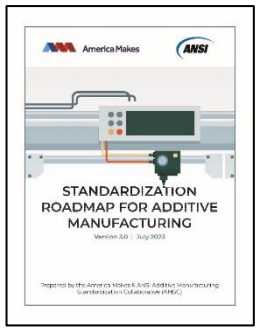
Heavy focus on metallic AM for aerospace, defense and medical industries



June 2018

Roadmap v2 Published

Added polymer content, electronic and electrical products industry



July 2023

Roadmap v3 Published

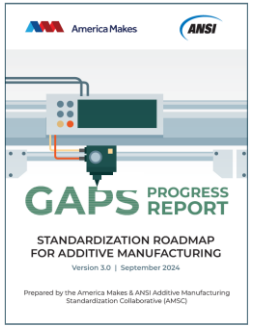
Added data WG, industry sectors, gaps metadata to augment filtering capabilities, current alternatives being used, R&D descriptions

April 2024

Gaps Progress Report Published

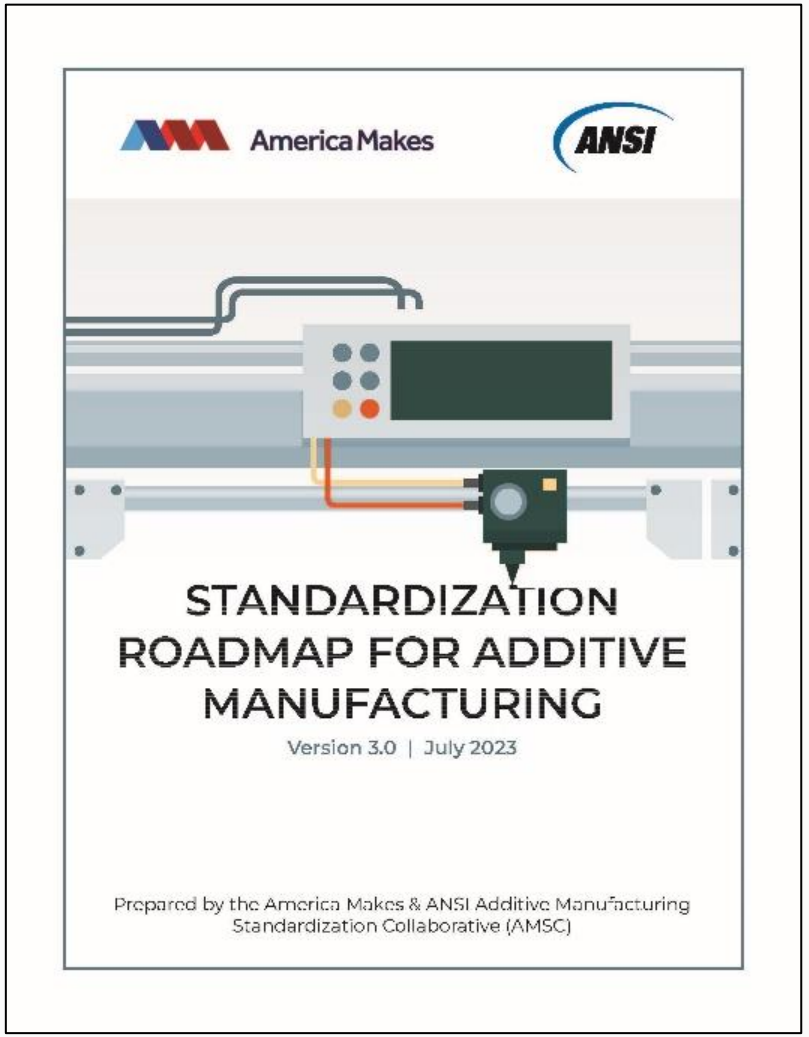
April & September 2025

Scheduled Future Gaps Progress Reports



Sept 2024

Gaps Progress Report Published



AMSC Roadmap v.3

- **AM Lifecycle Areas:**
  - Design, Precursor Materials, Process Control, Post-processing, Finished Material Properties, Qualification & Certification (Q&C), Nondestructive Evaluation (NDE), Maintenance and Repair, Data
- **Background Information**: AM issues, standards, specifications, codes, regulations, etc. that are published or in development
- **141 Gaps:**
  - **Recommend**: New / revised standards, organizations that can do the work, and priority levels
  - **Identify:** Captures any pre-standardization research & development (R&D) needs
  - **Suggest:** Intended applicability to sectors, materials, lifecycle/Q&C areas, process categories
- **Participation**: Approximately 300 individuals / 150 organizations

Breakdown of Open Gaps

Section	High Priority (0-2 years)	Medium Priority (2-5 years)	Low Priority (5+ years)	Total
Design	8	11	2	21
Precursor Materials	2	9	8	19
Process Control	2	8	3	13
Post-processing	1	4	3	8
Finished Material Properties	9	0	1	10
Qualification & Certification	13	10	3	26
Nondestructive Evaluation	5	6	1	12
Maintenance & Repair	1	4	2	7
Data	13	12	0	25
Total	**54**	**64**	**23**	**141**

91 Gaps Require R&D / 60 New Gaps

New Q&C Gaps in AMSC Roadmap v3

**High Priority*

Civil & Defense Aviation Industry (5)

- *QC17: AM Part Material Development Timeline*
- *QC18: OQ/PQ Process Know-How*
- *QC19: Workforce Training*
- *QC20: Certifying agency KPV Checklist*
- *QC21: Detailed Requirements Integration Document*

Electronics and Electrical Products Industry (1)

- *QC22: Additively Manufactured Electronics (AME)*

Oil & Natural Gas Industry (1)

- *QC28: Susceptibility of AM Products to Corrosion and Environmental Cracking Mechanisms*

Nuclear Industry (5)

- *QC23: Production and Incorporation of AM Parts in Nuclear Applications and Facilities*
- *QC24: Nuclear AM Component In-service Performance*
- *QC25: Nuclear Industry Use of Artificial Intelligence (AI) and Machine/System Learning Technologies to Qualify AM Parts*
- *QC26: Nuclear Industry Use of Material and Production Data Combined with Digital Analysis and Diagnostic Informed Qualification of AM Components*
- *QC27: Use and Qualification of AM Non-metallic Advanced Materials in Support of New or Advanced Nuclear Fuel and High-temperature Reactor Applications*

Materials

New Gap QC17: AM Part Material Development Timeline. Building an entirely new manufacturing process for a full suite of alloys requires a different approach than the historical consensus approach so that industry timelines can be met.

R&D Needed: ☒Yes; ☐No; ☐Maybe

R&D Expectations: Current state of technology does not allow material data set required. Use predictive modeling to replace testing, for example.

Recommendation: Develop standards, specifications, and allowables in concert to provide the industry a more robust material standards ecosystem.

Process Qualification & Process Control

New Gap QC18: OQ/PQ Process Know-How. Public research is required to demonstrate in a serial production environment the Key Process Variables (KPVs) and the required process controls to maintain stability. To date such work primarily has been developed privately and is held as a trade secret.

R&D Needed: ☒Yes; ☐No; ☐Maybe

R&D Expectations: See recommendation

Recommendation: Carry out research to demonstrate in a serial production environment the KPVs and required process controls to maintain stability.

Part Classifications

Gap QC2: AM Part Risk Classification System for Consistent Qualification Standards. A part classification system is used to describe the **level of risk** associated with a part and may therefore be used as a metric to gauge appropriate qualification requirements. The risk level is determined by two factors: (1) the part criticality as defined by the regulator, and (2) the likelihood or probability of the failure as determined by the OEM. A standard is needed to define common AM failure modes and a method for each failure mode to determine qualitative failure likelihood or quantitative failure probability. In most cases, this will provide guidance related to manufacturing variation effect on design margin.

R&D Expectations: ASTM AM CoE *Strategic Roadmap for Research & Development* (April 2020) notes that AM CoE Projects 1804/1907 (WK65937, WK65929) address AMSC gap QC2.

Recommendation: Develop a standard to define common AM failure modes and a method for each failure mode to determine qualitative failure likelihood or quantitative failure probability. A technical report describing existing risk classification systems for AM parts also would be useful. It could include the recommended minimum process and part qualification requirements commensurate with part risk for each classification level.

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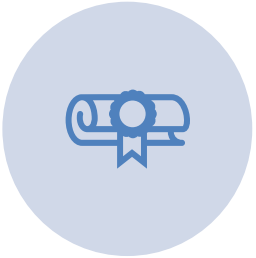
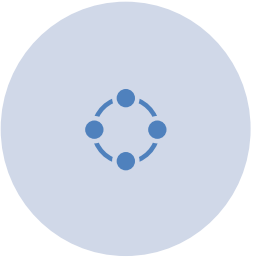
Conclusion



"Concepts of qualification and certification for AM are *not unique*"

"The "how" of AM qualification and certification […] *does not yet have broad consensus*"



"This should be expected given the breadth of the technology across *multiple process types and material classes*."

"*It will take time* for AM to develop what may be referred to as a common engineering practice"

"This will *come with the progression of standardization*"

"In the meantime, qualification and certification in AM will have to *rely upon open communication*"