Demonstration of Novel Methods for Effective AM Process Qualification/Re-Qualification - Delta Qualification (Delta Qual)

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Delta Qual

- 1 step response – Full proposal
- Standard full proposal format

America Makes RFP

Project Call for America Makes Applied Research Projects

Demonstration of Novel Methods for Effective AM Process Qualification/Re-Qualification - Delta Qualification (Delta Qual)

Prepared by

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Background

- Qualification of additive manufacturing (AM) machines and materials is a major barrier for the broad adoption of AM

- Generating data and models requires significant investment of resources and time in order to produce statistically significant data
  - Generating test coupons under a controlled process, performing testing, and analysis of the resulting data

- Established processes are “frozen”
  - No changes to key process variables allowed
  - Currently no standards-based guidance for what is required when change to the process is necessary or desired

- Only route forward for implementing change to a qualified process is total requalification
  - Can cost more than $3M per machine/material combination
  - Takes several years to complete

Greatly inhibits the agility of the AM processes to respond to changes in the tech base or supply base

Objectives

- Metal AM project which demonstrates the ability to rapidly and affordably update and/or establish a qualified AM process that can allow for changes in key AM process, post-processing, and/or material feedstock variables.

- Minor/Major Delta Qual – proposals should outline an approach to rapidly and affordably update a qualified AM process to allow for changes in key AM process, post-processing, and/ or material feedstock variables while validating a qualified AM material through statistical analysis in a manner similar to MMPDS, and at the same time leveraging prior and ongoing America Makes research as baselining efforts in collaboration with a specification and standards harmonizing “Red Team.”

- Red Team – proposals should outline an approach that includes research, mapping, and documentation of AM qualification approaches. Relevant standards shall be identified and evaluated to map commonalities in approaches, identify gaps, and propose areas for inclusion/improvement via Standard Organization's update mechanisms.
  - Establish a test matrix and test plan covering the various delta qualification efforts, factors, and considerations and subsequently draft material and process specifications incorporating these observations and lessons learned.

Topics

Topic 1 - Major Delta Qualification Demonstration

- Each proposer should seek to make a single change to the baseline process and seek to employ advanced numerical, analytical, and experimental methodologies to accelerate and reduce the cost of establishing equivalence to the baseline.

- Validation of qualified AM processes and materials should demonstrate equivalence using a statistically based approach similar to MMPDS (90% exceedance, 95% confidence interval) with a secondary goal of attaining validation through less testing, less time, and/or at a lower cost.

- Goal:
  - Achieve at least minimum equivalence to the performance of the baseline material
  - Responses limited to Powder Bed Fusion Ti-6Ai-4V grade 5 material
  - Boeing and Northrop will define technical requirements of re-qualification for their application space

Topic 1 - Major Delta Qualification Demonstration

- Potential areas for demonstrating the ability to modify process baselines are:
  - New machine type (make and model) qualification
  - New machine capability - multi-laser utilization, pulsed heat sources
  - New feedstock form - atomization method, size distribution, morphology
  - Heat source focus settings
  - Major machine software version change
  - New recoater type
  - New programmed layer height
  - Processing environment controls - enclosure features, gas flow, gas composition
  - New heat treatment/post-processing

Topic 2 - Minor Delta Qualification Demonstration

- Each proposer should seek to make a single change to the baseline process and employ advanced numerical, analytical, and experimental methodologies to accelerate and reduce the cost of establishing equivalence to the baseline.

- Validation of qualified AM processes and materials should demonstrate equivalence using a statistically based approach similar to MMPDS (90% exceedance, 95% confidence interval) with a secondary goal of attaining validation through less testing, less time, and/or at a lower cost.

- Goal:
  - Achieve at least minimum equivalence to the performance of the baseline material
  - Responses limited to Powder Bed Fusion Ti-6Ai-4V grade 5 material
  - Boeing and Northrop will define technical requirements of re-qualification for their application space

Topic 2 - Minor Delta Qualification Demonstration

- Potential areas for demonstrating the ability to modify process baselines are:
  - New machine location (same serial number machine)
  - New machine operator (personnel or organization) - same make and model
  - New powder (feedstock) supplier - same feedstock specification
  - Equipment subcomponent replacement - same make and model as original component
  - Minor machine software version change
  - New AM process parameter set (not including programmed layer height)

Considerations Topics 1 & 2

- **Responses to Topics 1 & 2 should consider:**
  - Establishing validated feedstock material forms, process controls, and repeatable and statistically significant quality (physical and mechanical properties) in a manner that is industrially relevant.
    - Proposers are encouraged to consider factors such as maintenance, calibration, and auditing to substantiate a controlled process workflow
  - Proposers should recognize that material and process specifications, control documentation, and other relevant controls will be communicated and reviewed by the "Red Team" to ensure a valid delta qual is successfully demonstrated.
  - Proposers should anticipate that discussions of approach, data management, and workflow control will occur between teams executing novel delta qualifications and other teams executing baseline qualification efforts.

Considerations - Topics 1 & 2

- Each effort awarded in response to Topic 1 shall conduct a go/no-go review with a government technical and Red Team of initial test matrix and test plan prior to executing testing.
- Each project shall deliver at a minimum tensile, compression, fatigue, modulus, fatigue crack growth, and fracture toughness data.
- All coupons will be inspected through various methods that will be documented in the required test plan.

Topic 3 - Red Team

- Responses to this topic will outline an approach that includes a metal AM process-specific team that will serve as subject matter experts to collect and harmonize AM standards and provide a map as to how Standard Organizations can include useful language for updating AM process qualification.

- The assembled “Red Team," in conjunction with a team of DoD stakeholders, will be responsible for evaluating the efforts of up to 6 other technical teams addressing Topics 1 and 2 of the Delta Qual RFP.
  - Key performance parameters for the technical teams will be defined and they will then be evaluated approximately three times per year

- The Red Team will collect lessons learned and success stories from across the technical teams and use this as input to recommendations for Standards Organizations to consider for inclusion in their AM standards.

Considerations – Red Team

- **Reponses to Topic 3 shall outline an approach to include:**
  - Attending technical team progress reviews and gathering lessons learned
  - Research, mapping, and documentation of AM qualification approaches
  - Identify relevant standards and evaluate to map commonalities in approaches, identify gaps, and propose areas for inclusion/improvement via Standard Organization's update mechanisms
  - Establish a test matrix and test plan covering the various delta qualification efforts, factors, and considerations and subsequently draft material and process specifications incorporating these observations, lessons learned, etc.
  - Assist in the evaluation of each Delta Qual effort's progress, identifying and recommending areas for improvement

Schedule

Event	Date
Project call announcement and posting	4/12/2023
Project Call Kick-off Webinar – Registration required: Delta Qualification Project Call kick-off	4/19/2023
Questions from proposers about scope or approach due	4/26/2023
Responses to proposers about scope or approach due	5/2/2023
Deadline for proposal lead to complete a fully executed America Makes Membership Agreement	5/8/2023
Fully Executed NDA with NCDMM (only if proposal contains proprietary information)	5/8/2023
Full project proposal submission due date (Note: No Concept Paper Submission)	5/22/2023
Anticipated decision and notification to project proposal teams	6/23/2023

Delta Qual – 8 Award(s)

Funding Description	Amount
Total Federal Funding Available (**not per award**)	$3,200,000
Max. Federal Award Topic 1 (**two awards anticipated**)	$700,000
Max. Federal Award Topic 2 (**four awards anticipated**)	$350,000
Max. Federal Award Topic 3 (**one award anticipated**)	$400,000
Minimum Cost Share	50%
Maximum Allowed Period of Performance (PoP) Topic 1 – shorter periods are acceptable	21 Months (18 months execution and 3 months reporting)
Maximum Allowed Period of Performance (PoP) Topic 2– shorter periods are acceptable	21 Months (18 months execution and 3 months reporting)
Maximum Allowed Period of Performance (PoP) Topic 3– shorter periods are acceptable	24 Months (21 months execution and 3 months reporting)

The number and type of demonstrations per topic is not fixed. AFRL and NCDMM reserve the right to select multiple awards, a single award, or no awards.

Eligibility

- The lead Proposer is a current member of America Makes and in good standing by Monday, May 8, 2023. Information on how to join America Makes is available at www.americamakes.us/membership.
- Cost share accrued in this project may also be applied towards membership, as with other project calls. However, cost share proposed on a future project cannot be counted towards a new America Makes membership. To become a member by the deadline, organizations shall commit to a cash payment and/or complete an @Program MOU.
- A 50% cost share is required for each project submittal. Example: If $1.00 of funding is requested from America Makes, $0.50 in cost share must be committed against that $1.00 for a total scope of $1.50.
- The lead Proposer is fully responsible for all project and subcontract performance.
- The lead Proposer shall be registered in U.S. System for Award Management (SAM) and have a Cage Code and DUNS number before submitting a proposal.
- Proposal team acknowledges that information from this project will be shared with America Makes members in accordance with the membership agreement.
- Proposal team arrangements are identified, and relationships are fully disclosed.

Minimum Deliverables Topics 1 & 2 Delta Qual Major/Minor

Minimum Deliverable	Timeline
Technical Progress Reports	Quarterly
Financial and man-hour reports	Monthly
Program Review meeting	Every 4 months
Presentations by the project team at 4 national meetings such as TRX, MMX, RAPID, etc. regarding the interim and final deliverables to promote the outcomes of the work Project team should plan to present at TRX at minimum once per project calendar year	Completed no later than 21 months after project award
Kickoff Meeting	1 month after award or sooner
Establish a conventional test matrix and test plan	3 months after award

Minimum Deliverables Topics 1 & 2 Delta Qual Major/Minor

Minimum Deliverable	Timeline
Identify and cite standards and material/process specifications to be leveraged by this program	3 months after award
Define powder reuse strategy	3 months after award
Statistically based mechanical property curves using one or more statistical methods consistent with a B-basis (90% exceedance/ 95% confidence interval) for Ti-6Al-4V	B-basis or equivalent 15 months after award
Final project report including at minimum: Critical process parameters, lessons learned, standards and specifications used, and any deviations from those standards and specifications Draft must be submitted no later than 18 months after award - minimum one round of revisions completed using feedback from PM/NCDMM and/or AFRL prior to final submission	21 months after award

Minimum Deliverables Topics 1 & 2 Delta Qual Major/ Minor

Minimum Deliverable	Timeline
Lead organization shall participate on at least one working group relevant to the subject matter of the project	Minimum of one presentation outlining all deliverables (CDIP, associated tangible artifacts, and associated roadmap requirements), KPP's, and data management plan within 60 days of project start date. Minimum of one presentation of milestone achievements, KPP's, and lessons learned relevant to the fulfillment or creation of roadmap requirements within 60 days of PoP end date. Hours attending and participating in meetings or activities shall be tracked and reported (regular meeting attendance is required)
Data management plan including at minimum: Any commercial software packages to be used, standards or data schemas to be used, and methodology for notating and labelling data to enable linking of various sample properties and characteristics, and plans for incremental delivery of data	Initial at time of proposal Final at first program review
Raw materials test data (feedstock, process, material, post-process, property) available in a static format and in a database with property meta-data (including CAD models and build files); non-destructive inspection data and meta-data	Delivered or posted to database regularly as available

Minimum Deliverables Topic 3 – Red Team

Minimum Deliverable	Timeline
Technical Progress Reports	Quarterly
Financial and man-hour reports	Monthly
Attendance at program review meetings for Topic 1 and 2 project teams	Approximately every 2 months
Presentations by the project team at 4 national meetings such as TRX, MMX, RAPID, etc. regarding the interim and final deliverables to promote the outcomes of the work Project team should plan to present at TRX at minimum once per project calendar year	Completed no later than 24 months after project award
Kickoff Meeting	1 month after award or sooner
Identify and cite standards and material/process specifications to be leveraged by this program	3 months after award

Minimum Deliverables Topic 3 – Red Team

Minimum Deliverable	Timeline
Draft language for including process change in standards	6 months after award
Consolidated and curated list of lessons learned, key recommendations, and draft language for Standards Organizations to consider for inclusion in their standards	23 months after award
Final project report Draft must be submitted no later than 21 months after award - minimum one round of revisions completed using feedback from PM/NCDMM and/or AFRL prior to final submission	24 months after award
Data management plan including at minimum: Any commercial software packages to be used, standards or data schemas to be used, and methodology for notating and labelling data to enable linking of various sample properties and characteristics, and plans for incremental delivery of data	

Minimum Deliverables Topic 3 – Red Team

Minimum Deliverable	Timeline
Schema and Data Compliance Reviews, Data shall: Be provided electronically, demonstrate pedigree and provenance, identify test apparatus/manufacturing/fabrication equipment and calibration, testing standards or processing specifications used including sample preparation and/or manufacturing equipment configuration, experimental/ characterization/manufacturing process conditions and procedures, raw mechanical test data, data reduction and statistical analysis procedures, uncertainty associated with data and method used to calculate uncertainty	Quarterly
Data Persistence Plan (how will data be stored and accessed after project conclusion)	Initial at proposal Final at 1st program review

Reporting

1. Technical progress reports
2. Virtual teleconferences with the project team
3. Virtual teleconference updates for government technical team and red team as necessary
4. Presentations at national meetings
5. Material and process specifications and standards along with any deviations
6. Financial and man-hour reports
7. Man-hour reports for attending working group meetings and supporting working group activities
8. Program review meetings
9. Kickoff meeting
10. Interim and final project reports

Reporting

11. Data persistence plan
12. Data management plan
13. One presentation to one working group (Design, Materials, AM Genome, or Value Chain) which outlines all deliverables (CDIP, associated tangible artifacts, and associated roadmap requirements), KPPs, and data management plan within 60 day after award (topic 1 and 2 responses only).
14. One presentation to one working group (Design, Materials, AM Genome, or Value Chain) which outlines all deliverables (CDIP, associated tangible artifacts, and associated roadmap requirements), KPPs, and data management plan within 60 days of project end (topic 1 and 2 responses only).
15. Reports, presentations, or teleconferences provided upon request by NCDMM or AFRL

Proposal and Contracting Information

- Executive Summaries must contain information that is publicly releasable, non-proprietary
  - Purpose
    - To aid in the America Makes public release process for award announcement
    - To demonstrate impact and merits of the Institute's efforts to the public

- No fee allowed

- Cover page should include DUNS and CAGE of at least team lead

- Teams must submit additional information to accelerate contracting
  - Sub-recipient agreement will be included in RFP, must be reviewed and any requested changes be sent in with proposal
  - No response certifies agreement as is upon award
    - Otherwise, award will be canceled

Evaluation Criteria

- **Executive Summary** (Executive summary is not scored but will be considered as part of the overall value proposition of the proposal)
- **Technical Approach and Methodology (60%) – 12 Factors**
- **Technical Dissemination to America Makes Members and Impact on the USAF (30%) – 5 Factors**
- **Program Management Approach (10%) – 5 Factors**
- **Cost** (Cost and cost share are not scored but will be considered as part of the overall value proposition of the proposal)

Questions

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