Statement of Work for NNA16570915Q-ALM

Fiber Reinforced Polymer Mold Tooling and Parts Production

A. Background/History of Requirement: NASA Ames is conducting a high level research program as part of the ARMD Convergent Aeronautics Solutions program. Key to this research will be the use of thousands of identical components with high manufacturing production quality. These components have complex geometry, and must have the mechanical properties of typical fiber reinforced polymer composites. The manufacturing method that has been identified as most closely meeting the needs of the program is equivalent to commercial production injection molding with multiple non-orthogonal (not perpendicular to mold pull direction) slides/side-actions. The mold will be tested for the performance of various materials, and up to 10,000 components of the most promising material may be purchased. These components will ultimately be used in a research project and subsequently as an experimental instrument in the in the lab for advanced manufacturing technology research, with novel material formulations.

B. Requirements Specifications:

1. Design of Mold Tooling
   a) ARC will provide CAD drawings of the part. The successful offeror will design injection molding tooling capable of producing the specified part.
   b) The mold tooling shall meet or exceed SPI Mold Class 102 and be capable of producing at least 10,000 parts.
   c) The part geometry is sparse with slender features, overall dimensions on the order of eight centimeters, and a total volume of about 1.5 cubic centimeters.
   d) The mold tooling is expected to be a two-sided mold with at least 2 edge gates, a modified trap runner system, at least 8 ejector pins (guided ejection), guide locks for alignment, and 12 mechanical slides (floats on both mold sides).
   e) Mold tooling materials shall meet or exceed the following:
      a. Cavity – H13
      b. Core – H13
      c. Slides – S7
   f) Deliverables:
      a. 3D CAD files (native format per a standard CAD package such as Solidworks, Creo, NX, etc. **and** step files of geometry alone) of mold assembly and all parts.
      b. Fully dimensioned manufacturing quality 2-D drawings (ps or pdf format).

2. Mold Flow Analysis
   a) Simulate and determine feasibility of part production.
   b) Optimize number of gates and runner system.
   c) Preliminary analysis of feasible resin formulations (i.e. fiber fill fraction).
   d) Analysis should determine a high specific modulus and strength solution with minimum performance equivalent to ~30% glass fiber filled nylon: specific gravity less than 1.5, effective elastic modulus more than 100 MPa, and strength greater

than 150 MPa). The goal is to find a solution or solutions with lower density and higher modulus and strength than this baseline.

e) Solution materials may include high fill fraction carbon fiber reinforced polyetherimide (PEI), liquid crystal polymer (LCP), polyurethane (PU), polycarbonate (PC), Nylon, low CF fill fraction formulations, high glass fiber fill fraction formulations, or low GF fill fraction formulations.
f) If the successful offeror do not have in-house resin compounding capability, it is expected they will work with ARC and a third party compounder to determine resin characteristics relevant to mold flow analysis.
g) Deliverable: Technical report containing description and visualization of expected pressure across mold geometry for a range of material types, fill fiber types, and fill fractions.

3. Production of Mold Tooling
   a) Produce a quantity of one mold tooling system that meets or exceeds SPI Mold Class 102 and is capable of producing at least 10,000 parts
   b) Mold tooling materials shall meet or exceed the following:
      a. Cavity – H13
      b. Core – H13
      c. Slides – S7
   c) Deliverable: Mold tooling system that meets specifications.

4. Materials Test Runs
   a) ARC estimates approximately four (4) machine hours will be required to produce a representative quantity of sample parts from each resin solution. The specific solutions to be tested will be determined by ARC following the completion of the Mold Flow Analysis phase. Since the different types of solutions are not known at this time, offerors shall propose a lump sum fixed price cost including four (4) fully-loaded machine hours (including, but not limited to, all labor, supplies and materials) for the test production of parts from each solution. It is preferred that this price include the cost of the selected resin solution(s). The offeror(s) shall specify what is included and excluded from their price. Anything not specifically excluded shall be included, as needed to complete performance of this task. The lump sum price for 4 machine hours will most likely be included on two (2) separately priced option line items, for a total test run time of 8 hours, if all options are exercised. ARC may elect to include up to a maximum of six (6) separately priced option line items in the resulting contract, for a total test run time of 24 hours.
   b) Test and determine a high specific modulus and strength solution with minimum performance equivalent to ~30% glass fiber filled nylon: specific gravity less than 1.5, effective elastic modulus more than 100 MPa, and strength greater than 150 MPa). The goal is to find a solution or solutions with lower density and higher modulus and strength than this baseline.
   c) Solution materials include glass or carbon fiber filled polyetherimide (PEI), liquid crystal polymer (LCP), polyurethane (PU), polycarbonate (PC), and nylon.
   d) If the successful offeror does not have in-house resin compounding capability, it is expected they will work with ARC and a third party compounder to test and

determine the high specific modulus and strength solution(s). The goal will be to work down the following list of material options until reliable part production is achieved (if the highest performance options work well, subsequent tests will not be necessary): high fill fraction carbon fiber reinforced PEI, LCP, PU, PC, Nylon, low CF fill fraction formulations, high glass fiber fill fraction formulations, low GF fill fraction formulations.

e) Deliverables:
    a. Delivery of manufactured parts to NASA Ames Research Center
    b. Technical documentation of the resin compound properties
    c. Delivery of a small quantity of resin (at least 8 ounces, to be used for dynamic mechanical analysis at NASA Ames Research Center).

5. Parts Production
    a) Produce quantities of parts using the selected solution from the Materials Test Run phase. ARC will select the solution following that phase. Production runs will consist of separately priced option line items of 2,000 parts each. ARC anticipates including a minimum of three (3) and a maximum of five (5) separately priced option line items, for a total possible production of of 10,000 parts if all options are exercised.
    b) It is preferred that this price include the cost of the selected resin solution. The offeror(s) may also quote prices for this task for each type of solution (a list of prices). The list of prices may be incorporated into the resulting contract and the value of this task would be determined from the quoted price for the selected solution. The offeror(s) shall specify what is included and excluded from their price. Anything not specifically excluded shall be included, as needed to complete performance of this task.
    c) Deliverables:
        a. Delivery of parts to NASA Ames Research Center within four weeks or less from the exercise of the option.

6. Period of Performance: Offerors to propose delivery dates for each phase above.