

Item Requirements

○ Article Name: Design for SLM (Selective Laser Melting) manufacturing of a combustion chamber, and Fabrication of chamber subcomponents by using the SLM process

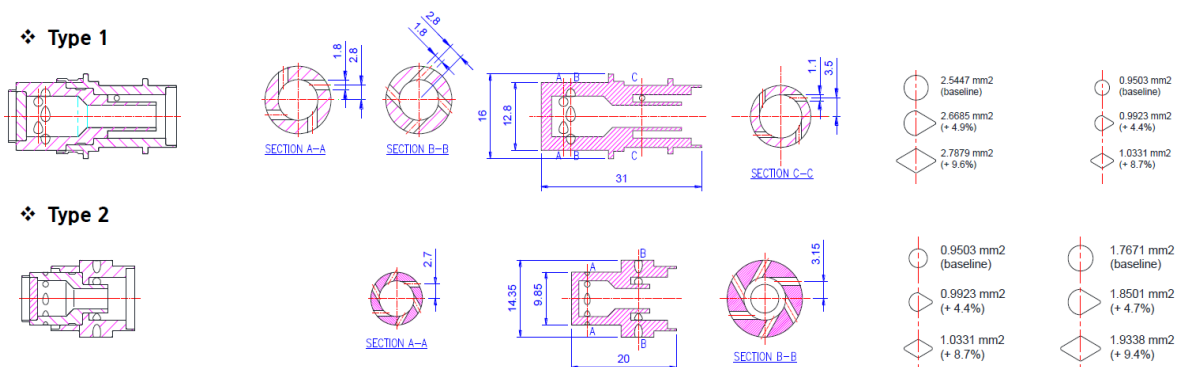
○ Type and Quantity

Item No.	Item	Q'ty
1	Design for SLM(Selective Laser Melting) manufacturing of a combustion chamber, and Fabrication of chamber subcomponents by using the SLM process - SLM manufacturing of injectors (1 set) - Design for SLM manufacturing of a combustion chamber (3 parts) - SLM manufacturing of a cylindrical part of the combustion chamber (1 part)	1 set

○ Latest Delivery Date: December 23rd, 2019

○ Requirements for injectors

Two types of injectors (Type 1 and Type 2) are manufactured using the SLM process as shown below, and three different shapes of holes are used for a given type.



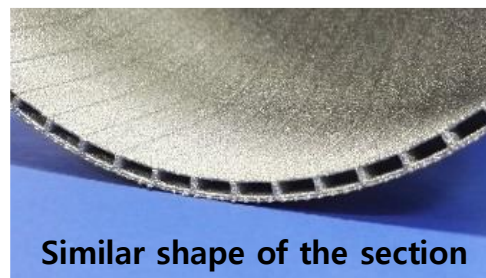
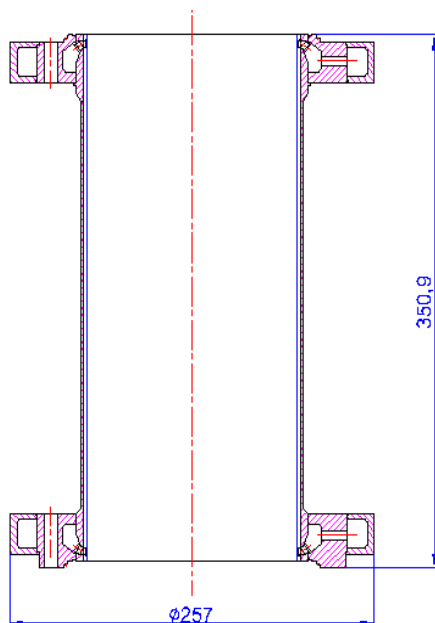
Six different designs in combination of type and hole shape are printed five each, totaling thirty injectors in one batch. Repeat the fabrication process three times and evaluate the deviation with fifteen copies of an injector design. UNS S31603 (STS 316L) in powder form shall be used as material for injectors, and a post-processing heat treatment shall be performed for stress relief of the injector parts. The table below lists numbers of printed

injectors for type 1 and 2. Total number of manufactured injectors is 90. The printed injectors shall be delivered to KARI (Korea Aerospace Research Institute) as soon as fabricating process is completed, regardless of latest delivery date. In the final delivery of the entire article, the delivery process shall be proceeded with the injectors KARI has received in advance.

Injector	Type 1	Type 2
Production times	3	3
Number of Different Hole Shapes per type	3	3
Copies of an Injector Design per Production	5	5
Number of printed injectors	45	45

○ Requirements for the cylindrical part of a combustion chamber

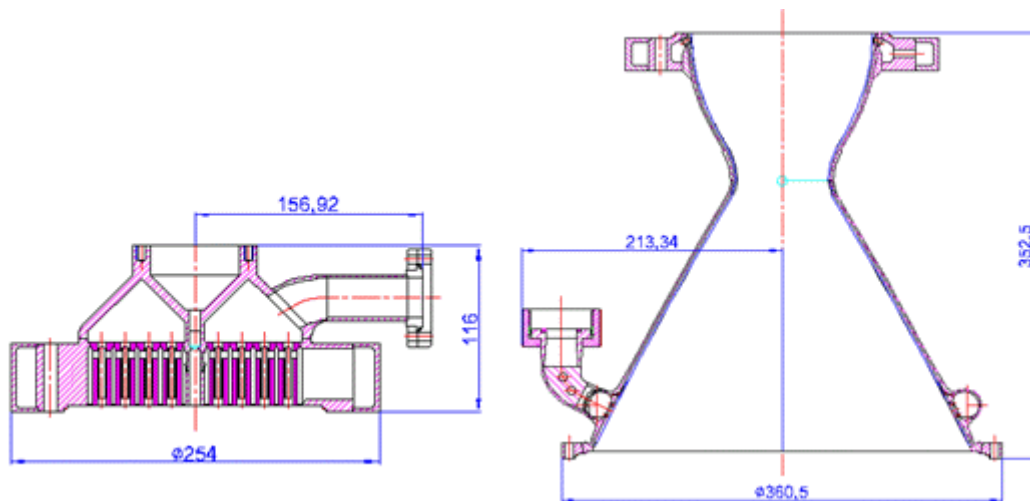
The design of the cylindrical part of a combustion chamber shall be modified to an SLM-applicable form and the contractor shall provide a recommendation for such modification through the consulting process with KARI. The SLM process shall be used to fabricate the cylindrical part. KARI will provide a drawing required for fabrication but a modification of the drawing for a SLM process shall be done by the contractor. Inconel 718 in powder form shall be used as material and a heat treatment shall be applied after the SLM process for stress relief.



Coupons for tensile tests shall be produced with the cylindrical part simultaneously, and provided to KARI so that the mechanical properties of the printed material be verified; approximately, ten coupons are desirable, but number of coupons can be adjusted depending on the technical limitation.

- Requirements for head and nozzle parts of a combustion chamber

Design of the head and nozzle parts of a combustion chamber shall be modified to an SLM-applicable form, and the contractor shall provide recommendations for such modifications. KARI will provide a drawing required for modification but a modification of the drawing for a SLM process shall be done by the contractor. Manufacturing of these parts is not included in the contract, and CAD files for the completed design shall be delivered as a result of the design consulting service.



- Precautions

- All products shall be manufactured by the SLM (Selective Laser Melting) process
- All products shall be stress relieved and the report of heat treatment shall be delivered
- All products shall go through either sand blasting or shot-peening
- The production recipe and report shall be provided.
- All data generated by this contract shall not be conveyed to the third party without a prior approval of KARI, and must be destructed upon termination of the contract.
- KARI engineers may visit the manufacturing site to examine the SLM process.
- The Contractor shall provide photographs and videos of the production process.
- Dimensional accuracy and surface roughness after surface treatment are required as follows:

	Dimensional Accuracy	Surface Roughness
Injectors	$\pm 20\sim 50 \mu\text{m}$	Ra $5 \pm 2 \mu\text{m}$
Cylindrical Part	$\pm 0.2 \%$	Ra $4 \sim 6.5 \mu\text{m}$

○ Payment terms

Payment for the contract shall be made as follows:

Ratio	Payment terms
10% \pm 5%	After signing the contract
50% \pm 5%	Delivery of the design
40% \pm 5%	Deliver of all parts